MACHINERY.

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PROBLEMS IN BEAMS AND PLANES SEVERALLY SUPPORTED AND ECCENTRICALLY LOADED.

C. F. BLAKE

Among the troublesome problems that sometimes occur to the designer are the cases of beams carrying a concentrated load, or loads, and borne upon several supports, the reaction upon these supports being required. Such problems, however, may be easily solved by an application of the principles of the polar moment of inertia. Attention has already been called by the writer to the advantages of the application of these principles to the design of riveted joints, but as the usefulness of the polar moment of inertia method is not as well recognized as it should be, a few remarks upon its use in general may not be out of place before applying the method to the problems in hand.

The general formula for equilibrium under the polar system of co-ordinates is the same as that for the rectangular system with the subscript $_p$ added to the proper quantities to denote that they refer to the polar system.

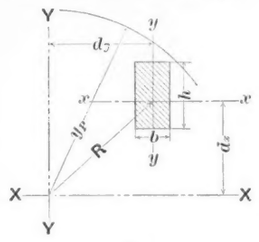

Fig. 1

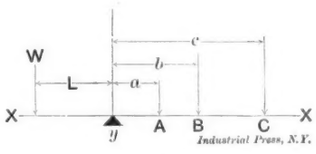

Fig. 2.

$$M = f\frac{I_p}{y_p} = f\,Z_p \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where M = the moment about the pole in inch-pounds.

f = the fiber stress upon the most remote fiber from the pole.

y_p = the distance from the pole to the most remote fiber,

I_p = the polar moment of inertia,

Z_p = the polar section modulus.

If, when considering the torsional resistance of any section about a given pole, we draw through that pole a system of rectangular co-ordinates, XX and YY, the polar moment of inertia of the section will be the sum of the two co-ordinate moments of inertia about these axes. Thus, referring to Fig. 1, let I_x and I_y be the co-ordinate moments of inertia of the section about the x and y axes respectively, these axes being drawn through the center of gravity of the section. Then from the well-known formula, the moments of inertia about the axes XX and YY respectively, are:

$$\left.\begin{aligned} I_X &= I_x + A\,d_x^2 \\ I_Y &= I_y + A\,d_y^2 \end{aligned}\right\} \text{ where } A = \text{the area of the section.}$$

Then, $$I_p = I_X + I_Y = I_x + I_y + A\,R^2$$

Where several sections are grouped about a pole, the total moment of the group is the sum of the several polar moments taken separately as above for each section.

Thus for any number of sections,

$$I_p = \Sigma\,(I_x + I_y + A\,R^2) \quad \ldots\ldots\ldots\ldots (2)$$

and substituting this value in (1) we have,

$$M = f\frac{\Sigma\,(I_x + I_y + A\,R^2)}{y_p} \quad \ldots\ldots\ldots\ldots (3)$$

and

$$Z_p = \frac{\Sigma\,(I_x + I_y + A\,R^2)}{y_p} \quad \ldots\ldots\ldots\ldots (4)$$

At present we are dealing with loaded points instead of sections, so I_x, I_y, and A approach zero, and (4) reduces to

$$Z_p = \frac{\Sigma\,A\,R^2}{y_p} \text{ approximately} \quad \ldots\ldots\ldots\ldots (5)$$

From this we see that the torque set up by the reaction of a point is directly proportional to the square of its distance from the axis of rotation, and it is this fact upon which the following solutions depend.

In Fig. 2 let XX be a beam supported at y, loaded by a known load W at a distance L from this support, and prevented from rotating about y by the reaction of several points, A, B, and C, distant respectively a, b, and c from the support. Required the reactions A, B, and C. The torques of the reactions at the several points on the right of the support are proportional to the squares of their distance from y, therefore the total torque on the right of y is proportional to $(a^2 + b^2 + c^2)$, and the torque obtained from reaction

$$\left.\begin{aligned} A &= \frac{a^2}{a^2 + b^2 + c^2} \\ B &= \frac{b^2}{a^2 + b^2 + c^2} \\ C &= \frac{c^2}{a^2 + b^2 + c^2} \end{aligned}\right\} \text{ of the total torque,}$$

WL, on the left of y.

Since a force exerting torque about an axis is equal to the torque divided by the arm at which it acts, we have the force

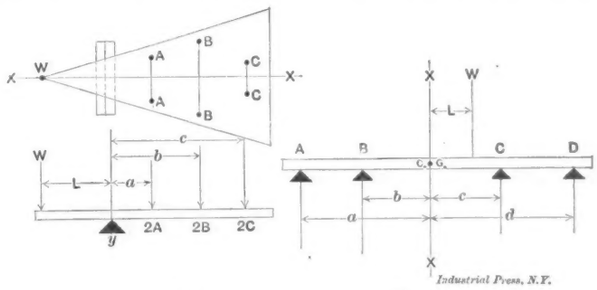

Fig. 3.

Fig. 4.

$$A = \frac{\dfrac{a^2}{(a^2 + b^2 + c^2)}\,W\,L}{a} = \frac{W\,L\,a}{a^2 + b^2 + c^2} \quad \ldots\ldots (6)$$

Likewise the force

$$B = \frac{W\,L\,b}{a^2 + b^2 + c^2} \quad \ldots\ldots\ldots\ldots (7)$$

and

$$C = \frac{W\,L\,c}{a^2 + b^2 + c^2} \quad \ldots\ldots\ldots\ldots (8)$$

Thus, having the values of W, L, a, b, and c, we arrive at values for A, B, and C such that, acting through their respective arms a, b, and c, they will balance the force W acting through its arm L.

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Having found the values of A, B, and C, the force upon the support y is

$$W + A + B + C.$$

This is applicable no matter how many points of reaction there may be, nor how they are placed, so long as they are symmetrical about a line drawn through W. This is shown in Fig. 3, which represents a plane balanced upon a knife edge, having a load W on the left, and several points of reaction on the right, these points being symmetrically placed about the line $x\,x$. This problem may be treated exactly as that shown in Fig. 2, the resulting load upon the knife edge being uniformly distributed.

If the points are not symmetrical about $x\,x$, the same method may be used, but the resulting load upon the knife edge will not be uniformly distributed. Fig. 4 represents a beam severally supported at A, B, C, and D, and loaded at W. The line $x\,x$ is drawn through the center of gravity of the supports A, B, C, and D. The reaction of each support due to the torque WL is found by formula (6). Note must be made of the directions of these reactions; in Fig. 4 the load W would, in the absence of the supports, rotate the beam clock-wise about the center of gravity, hence the forces A and B are up, and the forces C and D are down. In algebraic addition to these loads at the several supports, each support will have a vertical load down of $\frac{W}{n}$ pounds, where n is the number of supports. Thus in Fig. 4 the load at A is

$$A = \frac{W}{n} - \frac{W\,L\,a}{a^2 + b^2 + c^2 + d^2} \quad \ldots\ldots\ldots (9)$$

and the load at C is

$$C = \frac{W}{n} + \frac{W\,L\,c}{a^2 + b^2 + c^2 + d^2} \quad \ldots\ldots\ldots (10)$$

etc., n being 4 in the case of Fig. 4.

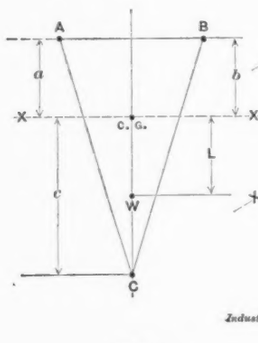


Fig. 5.

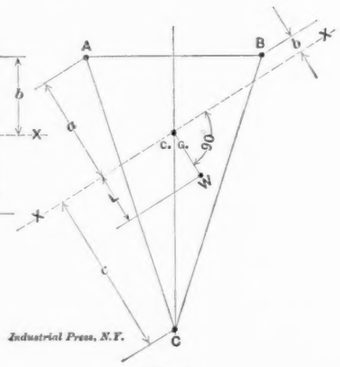


Fig. 6.

Let Fig. 5 represent a plane severally supported at A, B, and C, and loaded at W; required the reactions at the supports. Locate the axis of rotation $x\,x$ through the center of gravity of the supports. Each support resists a down load of $\frac{W}{n}$, and at the same time a load due to the torque of WL about the axis of rotation $x\,x$, precisely as in Fig. 4, and the same formula (9) may be used.

Fig. 6 is the same as Fig. 5, except the load is not symmetrically placed as regards the supports. Locate the center of gravity of the supports, and connect this with the point of loading W. Through the center of gravity perpendicular to this line draw the axis of rotation $x\,x$. From each point of support drop a perpendicular to $x\,x$, thus getting the arms at which the reactions act. The reactions at the supports may now be obtained by formula (9). The method of Fig. 6 is applicable to any plane severally supported and loaded, since W may represent the center of gravity of any number of known loads upon the plane, and the formula may be extended for any number of supports.

A graphical solution for formula (9) sometimes convenient is as follows: In Fig. 7 draw the rectangular axes xx and yy, and lay off a unit of the selected scale on xx. Also on xx lay off the arms at which the reactions act, a, b, and c, obtaining points A, B, and C. At these points erect perpendiculars, and also through these points pass arcs $A1$, $B3$ and $C5$, with o as center. Through the points 1, 3, 5, where these arcs cut the perpendicular from the unit point, pass radial lines from o, and extend them to meet the respective perpendiculars from A, B, and C at points 2, 4, and 6 respectively. Then

$$\frac{o\,1}{\text{unit}} = \frac{o\,2}{o\,A}$$

and since the unit equals 1, and $oA = o1 = a$, we have

$$\frac{a}{1} = \frac{o\,2}{a}, \quad o\,2 = a^2.$$

Likewise $o4 = b^2$ and $o6 = c^2$. With a radius equal to L, describe an arc cutting the unit perpendicular at 7, and draw a

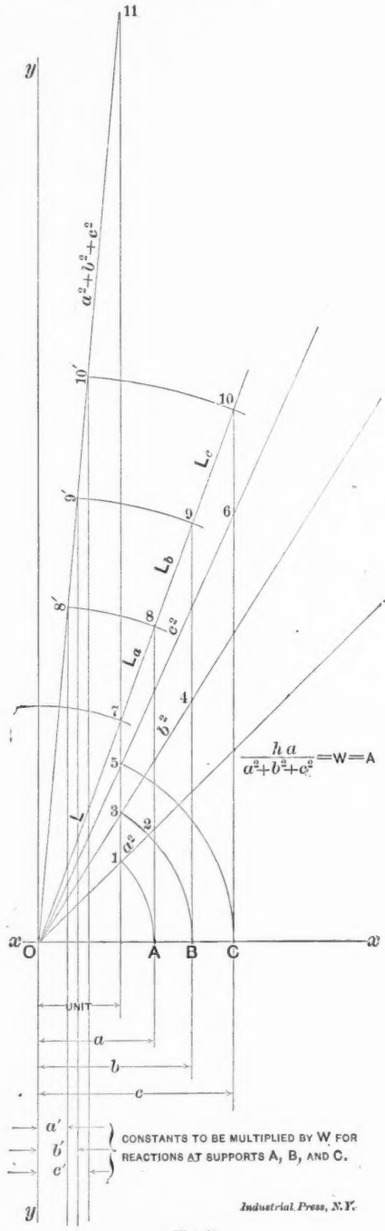


Fig. 7.

radial line through this point to cut lines from A, B, and C in 8, 9, and 10. Then $o8 = La$, $o9 = Lb$, and $o10 = Lc$.

Having found the lines representing a^2, b^2, and c^2, set the dividers to a radius equal to the sum of these lines, and with an arc cut the unit perpendicular at H. Draw oH. Transfer points 8, 9, and 10 to 8', 9', and 10' on line oH by means of arcs struck from o, and from the latter points drop perpendiculars. The distances a', b', and c', when measured to the adopted scale, and multiplied by W give the reactions at A, B, and C respectively.

Like the formula, this diagram may be extended to cover

any number of points of reaction. As in all written descriptions of graphical methods, the actual work required is far short of what seems necessary when first read, and is in reality very simple. The range of problems to which this method is applicable is very great, including the loads carried by machinery foundations, car loadings, beams, anchor plates, and many intricate details of machine design, in short any problem, no matter how intricate, that may be reduced to a plane supported upon several points, and carrying one or more loads, the center of gravity of which is known. The following problem will serve as an illustration:

Fig. 8 represents a four-legged spider or anchor plate, loaded as shown; the arms being of varying lengths we require the reaction at each support, in order to proportion the arm sections.

Draw B C and bisect it at e, also bisect A D at f. Join e and f, and bisect e-f at g. Then g is the center of gravity of the

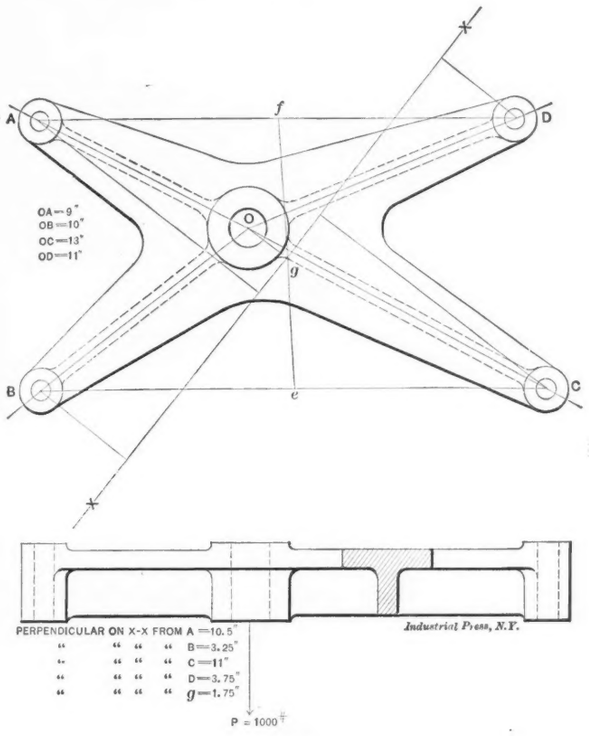


Fig. 8.

supports A, B, C, and D if the load on each one is unity. Draw o g, and x x perpendicular thereto, and upon x x drop perpendiculars from A, B, C, and D.

We then have from formula (6),

$$\text{Load at } A = \frac{1000 \times 1\ 75 \times 10.5}{(10.5^2 + 3.25^2 + 11^2 + 3.75^2)} = 71.9 \text{ lbs. downward.}$$

$$\text{Load at } B = \frac{1000 \times 1.75 \times 3.25}{(10.5^2 + 3.25^2 + 11^2 + 3.75^2)} = 22.14 \text{ lbs. downward.}$$

$$\text{Load at } C = \frac{1000 \times 1.75 \times 11}{(10.5^2 + 3.35^2 + 11^2 + 3.75^2)} = 75.35 \text{ lbs. upwards.}$$

$$\text{Load at } D = \frac{1000 \times 1.75 \times 3.75}{(10.5^2 + 3.25^2 + 11^2 + 3.75^2)} = 25.63 \text{ lbs. upwards.}$$

1000 lbs. $\times$ 1.75 inch lbs. = 1750 inch lbs.

$$\begin{array}{rl} 71\ 9 \times 10.5 & = 754\ 95 \text{ inch lbs.} \\ 22.14 \times 3.25 & = 71.955 \\ 75.35 \times 11 & = 828.850 \\ 25.63 \times 3.75 & = 96.112 \\ \hline & 1751.867 \text{ inch lbs. check.} \end{array}$$

$$\text{Vertical load on each arm} = \frac{1000}{4} = 250 \text{ lbs. downward.}$$

$$\begin{array}{rl} \text{Resultant on } A & = 250 + 71.9 = 321\ 9 \\ \text{" " } B & = 250 + 22.14 = 272.14 \\ \text{" " } C & = 250 - 75.35 = 274.65 \\ \text{" " } D & = 250 - 25.63 = 224\ 37 \\ \hline & 1093.06 \text{ lbs. check.} \end{array}$$

The error, less than ten per cent., arises from dropping decimals in taking squares, and from slide rule readings, but the check is as close as practice demands.

* * *

VARIABLE SPEED MOTORS.—4.

THE BULLOCK SYSTEMS.

WILLIAM BAXTER, JR

The Bullock Electric Mfg. Co. use two systems for variable speed motors, one three- and the other four-wire. The three-wire system is arranged so as to give three different voltages, and the four-wire gives six. Thus by means of voltage variations, three speeds are obtained in one case, and six in the other. Intermediate speeds between those given by the several voltages are obtained by introducing resistance in the field circuit.

A diagrammatic representation of the four-wire system is given in Fig. 1, in which the upper part is a development of the controller, and the lower shows the general arrangement of the balancing transformer. This balancer is shown as consisting of three machines, but it is also made in the form of two machines, one of these being provided with two separate windings on the armature, and two commutators.

In Fig. 1 the lines + and — represent the mains coming from the generator to a two-pole switch S. Through a, the current passes to an automatic motor starter and thence through the armature and series field coil of the left-side machine, to line b. From the end of the series field of the first

TABLE 1. RHEOSTATIC CONTROL.

Amperes.		Volts.		Speed.			Work.		Diameter Piece.	Tool Position.
Arm.	Field.	Arm	Line	R. P. M. Motor.	R. P. M. Spindle.	Feet Peripheral.	Feed.	Depth.		
16.2	.82	179	236	652	218	210	.....	.....	....	A
25.7	"	54	"	203	67.6	65.3	21 to 1	$\frac{1}{64}$"	$3\frac{11}{16}$"	E
27.3	"	43	"	161	50.0	48.3	"	$\frac{1}{32}$"	"	C
33.6	"	....	"	.....	.....	.....	.....	$\frac{1}{16}$"	"	D

TABLE 2. RHEOSTATIC CONTROL.

Amperes.		Volts.		Speed.			Work.		Diameter Piece.	Tool Position.
Arm	Field.	Arm.	Line	R. P. M. Motor.	R. P. M. Spindle.	Feet Peripheral.	Feed.	D'pth		
16.2	.82	179	236	652	218	210	.....	.....	....	A
53.5	"	53	"	189	63	60.8	21 to 1	$\frac{1}{8}$"	$3\frac{11}{16}$"	B
38.5	"	105	"	378	126	121.5	"	$\frac{1}{16}$"	"	C
27.3	"	143.2	"	515	172	165.5	"	$\frac{1}{32}$"	"	D
25.7	"	148.6	"	535	178.5	172.5	"	$\frac{1}{64}$"	"	E

machine the circuit branches and passes through the armature of the second machine and thence through the series field coil to wire c. From c another branch passes through the armature of the third machine and through the series field coil to wire d. The wires a b c d run to a four-pole switch S', by means of which the lines that feed the motors are connected or disconnected from the main, and the balancer circuits, whenever desired. Each motor is in addition connected with the main motor circuits by means of a four-pole switch as shown at S''.

The balancers, as will be noticed, are compound wound, the object being to maintain the voltage between the several lines more nearly constant than it would be with a plain shunt winding. The way in which the compound winding acts to keep the E. M. F. more uniform will be explained in connection with the three-wire system. The shunt field coils are connected directly across the generator lines, each one in a separate circuit, and provided with its own regulating rheostat.

The three balancer machines develop voltages of 60, 80 and 110, and by combining these, six different voltages are ob-

tained, as is shown at the right side of the diagram. As the lowest voltage is 60 and the highest 250 the speed variation due to voltage alone is a little more than 4 to 1. By the aid of field regulation the total range of speed of the motor is about 7½ to 1. The resistance introduced into the motor field to obtain the additional regulation is proportioned so that four speeds are obtained with each voltage, except the highest, with which six speeds are obtained, thus making the total number of speeds 26. As the lowest voltage is only about one-quarter of the highest, no starting resistance is required in the armature circuit, and this fact materially simplifies the construction of the controller.

The controller is of the cylindrical type, and consists of two cylinders, *A* and *B*, one of which carries the part marked "Drum 1" in the diagram, and the other carries drums 2, 3 and 4. These two cylinders are connected with each other by means of a specially arranged gearing, so that while drum 1 has a uniform motion, the other cylinder moves step by step. The cylinder *A* that carries drum 1 drives the other cylinder. When cylinder *A* is moved to the first position, it carries cylinder *B* to the first position; but while *A* is being moved toward position 2, *B* stands still and does not move until *A* reaches the second position, when it moves rapidly to position 2.

The four rectangles in the diagram, marked "drums," are metallic plates that encase the cylinders and have raised contacts at the points indicated by black circles and bars. The three drum plates on cylinder *B* are insulated from each other. When the motor is stopped the stationary contacts shown at the right of cylinder *B* rest along the center line of the diagram, so that if the cylinder rotates to the right the motor will be connected so as to rotate in the forward direction; and if it is turned to the left the motor will be connected to revolve in the reverse direction. If the controller handle is turned in the direction to give the motor the forward motion, drum 1 will move to the left, under the stationary contacts drawn at the left; the cylinder *B* will rotate to the right so as to move the contacts on the left side of the drum under the stationary contacts, which it will be remembered rest along the center line of the drums. On the left side of the drums, on cylinder *B*, the second row of contacts from the top on drum 3, and the second row from the bottom on drum 2 will connect with the motor armature terminals. The middle row of contacts on drum 3 will connect with wire *a''*. Wire *b''* will connect with the middle row of contacts on drum 2 and with the second row from the bottom on drum 3. Wire *c''* will connect with the second row of contacts from the top on drum 2, and with the bottom row on drum 3. Wire *d''* will connect with the top row of contacts on drum 2.

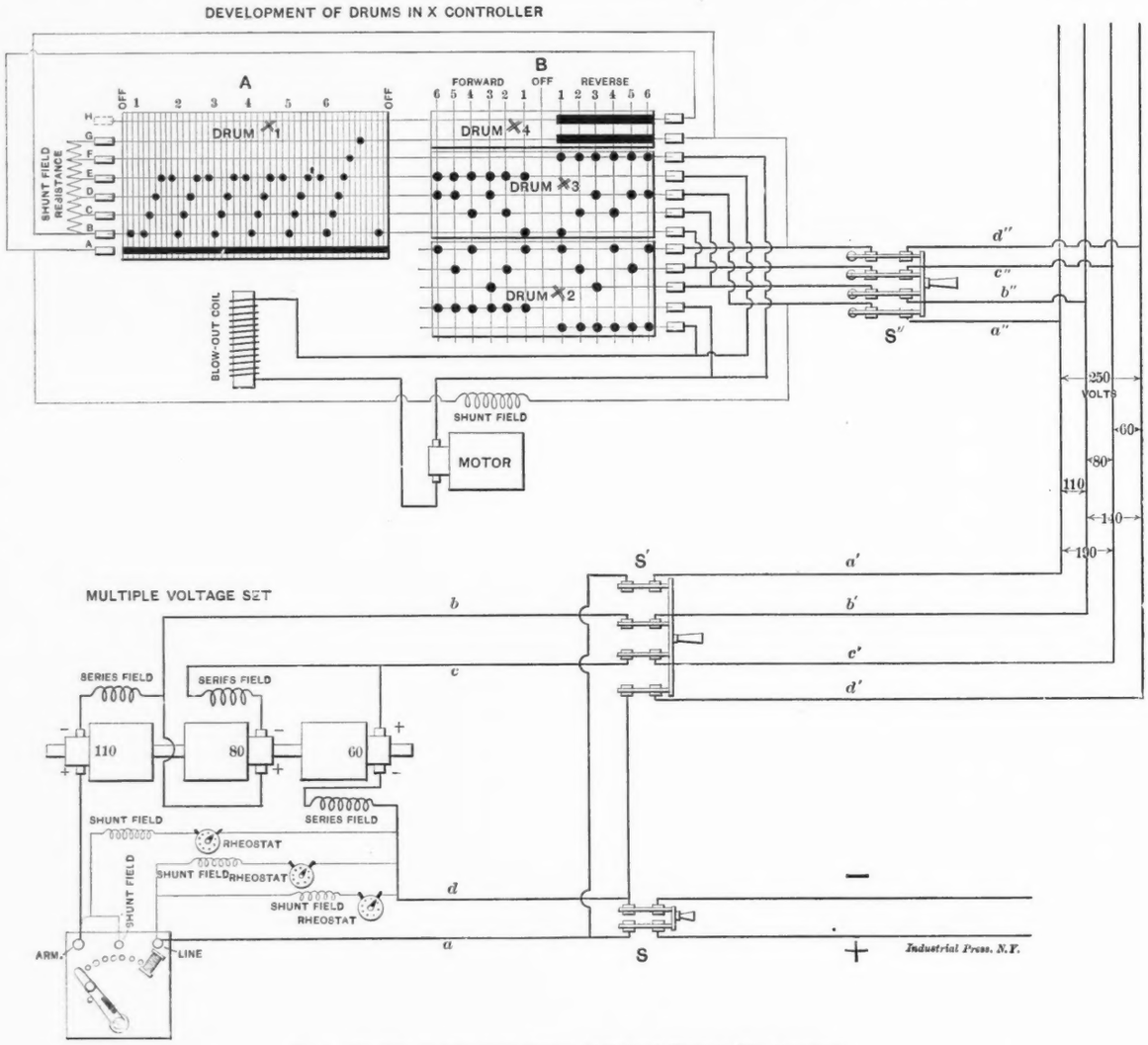


Fig 1 Diagram of Four-wire System of Bullock Electric Mfg. Company.

From wire *d''* a shunt connection runs to stationary contact *B*, of cylinder *A*, which contact is connected with one end of the shunt field resistance. From wire *a''* another shunt connection runs to the shunt field coil of the motor, and thence to stationary contact *A*, of cylinder *A*.

Keeping the foregoing connections in mind it will be seen that when the controller is moved to the first forward step, the motor armature terminals are connected with wires *c''* *d''*, which give the lowest voltage, and the shunt field circuit will be closed through the stationary contacts *A B* of cylinder *A*, which will be resting on the two lower rows of projections on drum 1. As cylinder *A* is further advanced, stationary contact *C* will ride over the third projection, while contact *B* will pass off the second projection, and thus one section of the shunt field resistance will be cut into the circuit. This

will reduce the current through the field coil and increase the motor speed. As cylinder *A* is further advanced, the contacts *D* and *E* will come in contact with drum 1, successively, thereby cutting additional resistance into the shunt field circuit, and further increasing the motor speed. When cylinder *A* reaches the second position, all the field resistance is cut out, stationary contacts *A* and *B* being the only ones in contact with drum 1. At this same instant cylinder *B* advances to the second position and then the armature terminals of the motor

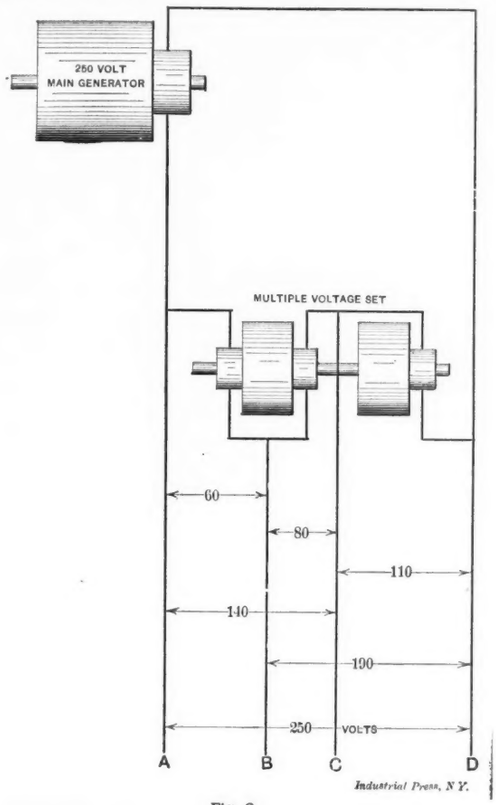


Fig. 2.

are connected with wires *b″ c″*, which give the second voltage, with which the motor speed is a little greater than that obtained with the first voltage and all the resistance cut into the shunt field circuit.

The continued advance of the controller toward position 3 causes the *A* cylinder to repeat the operation of cutting the several sections of the shunt field resistance into the circuit, and when the third step is reached, cylinder *B* will change the motor armature connections from wires *b″ c″* to wires *a″ b″*, while cylinder *A* will again cut out the field resistance. In the further movement of the controller the action of cylinder *A* will be a repetition of what has been just explained; that is, after each step is reached the sections of the field

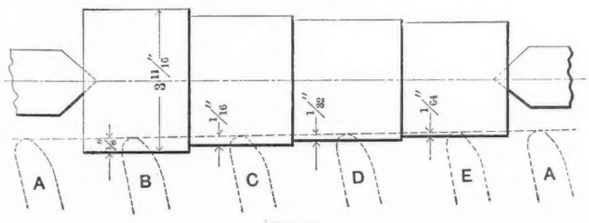


Fig. 6.

resistance are cut into the circuit, and when the next step is reached they are all cut out. The cylinder *B*, in advancing from step to step, simply changes the motor armature connections with the line wires so as to increase the voltage at each step until the highest voltage is reached.

Drum 4 does not come into action except when the motor is reversed, and its office is simply to short-circuit the shunt field resistance; so that in the reverse motion the motor can only give six different speeds, but the range of velocities is the same as on the forward motion.

It will be noticed that cylinder *A* does not cut in all the field resistance until the sixth step is reached, so that between the other steps there are three gradations of speed effected by the introduction of resistance, and on the last step there are five. This makes 20 speeds that are obtained by the introduction of resistance in the shunt field circuit, and these added to the six obtained with the different voltages give a total of 26 speed variations.

When the four-wire system is installed in an establishment where there is no electric plant, a generator capable of giving the highest voltage is provided, as illustrated in the diagram, Fig. 2, and the intermediate voltages are obtained by means of the balancer. If an electric plant is already in use, and the voltage is high enough, the balancer connections will be the same as in Fig. 2, but if the E. M. F. of the existing plant is too low, the balancer connections are modified in the manner shown in Fig. 3.

In Figs. 2 and 3 the balancer shown is of the two-armature type, one of these armatures being provided with two separate windings, each one being connected with an independent commutator. As indicated in the diagrams, one of these armature windings develops an E. M. F. of 60 volts, and the other 80 volts, and as both windings are connected in series, through the commutator brushes, their combined voltage is 140.

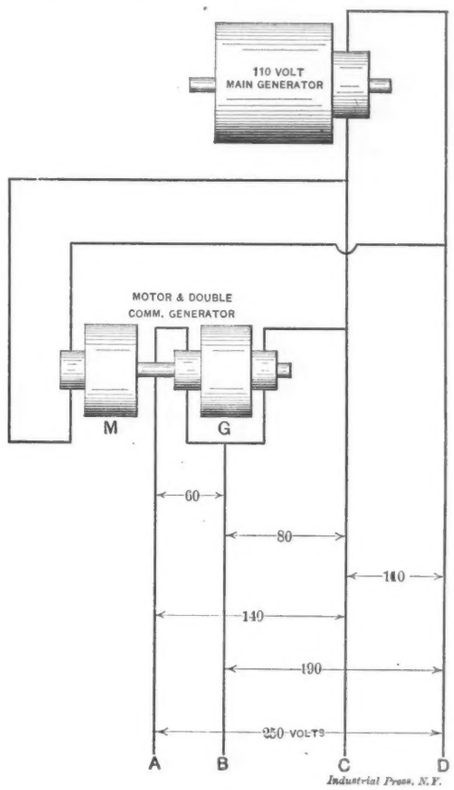


Fig. 3.

The action of the balancer in Fig. 3 is not the same as that of Fig. 2. The latter is a true balancer, and both armatures can act as motors or generators, as the case may require. In Fig. 3, however, the single-commutator machine acts at all times as a motor, and its office is to furnish the necessary power to drive the double-commutator machine which acts as a generator. If there are no motors connected with line *A*, no current will be generated in the 60-volt circuit of the armature. If there are no motors connected with line *B*, the current drawn from line *A* will pass through both the windings of *G*. If there are no motors connected with either line *A* or line *B*, no current will be generated by *G*. In any case, however, motor *M* will furnish all the power necessary to drive *G*. From this it can be seen that as *M* simply provides power to drive *G* it may be replaced by a steam engine, or by a belt connection with a main line of shafting, or any other source of power.

If the generator is large enough to furnish all the current

required to operate the motors a motor generator set as shown in Fig. 3 can be used; but when the main generator is not large enough, then power from some other source must be provided to drive *G*, and in such a case the latter will be simply a double-current generator added to the generator already in use, connected with the latter in the way shown in the diagram, so as to form a four-wire distributing system.

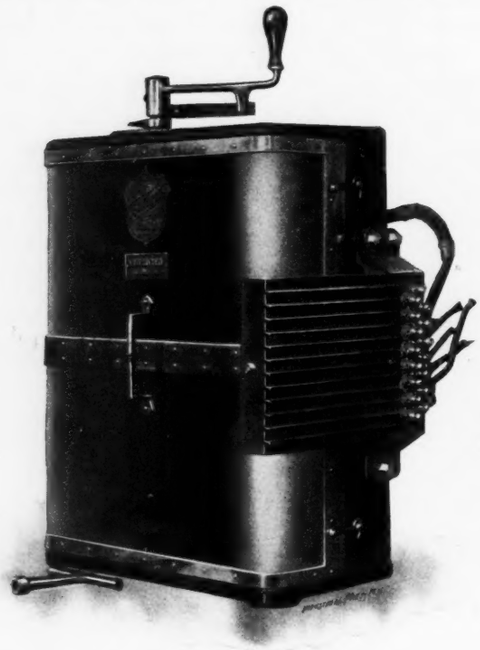


Fig. 4.

When a balancer is connected in the way shown in Fig. 2, the sum of the voltages of the armatures cannot be greater than that of the main generator, but will always be somewhat less, the difference depending on the amount of current passing through the circuit; but when a motor generator set is connected in the way shown in Fig. 3, the voltages developed in the generator armature may be as much in excess of the main generator E. M. F. as may be desired. Hence this arrangement is advantageous in cases where a 110-volt plant is in service for lighting purposes, and it is desired to obtain higher voltages for the operation of motors.

The arrangement of Fig. 3 can be used with a three-wire system as well as with the four-wire. As can be readily seen, if generator *G* has a single armature winding with one commutator, one of the brushes can be connected with *B*, and the other with *C*, just as in the diagram. The only difference between a three-wire system arranged according to Fig. 3, and a four-wire system is that with the former the voltage cannot be increased much. With the four-wire system, if the main generator E. M. F. is 110 volts, the maximum voltage can be 250 if the intermediate voltages are as indicated in Fig. 3; but with a three-wire system the maximum would be 190 volts. As a matter of fact it would be less, because 80 volts would be too high for the low E. M. F., which should be 60 or 70, so that the maximum would be 170 or 180.

The controller used with the four-wire system is shown in Fig. 4. The handle by which it is operated is mounted on the shaft of cylinder *A*, Fig. 1. The shunt field resistance is attached to one side of the controller. When the machine driven by the motor is of such a type that the controller can be conveniently operated by means of the handle on top, this arrangement is used, but in cases where it is necessary to operate the controller from a distance, suitable connecting shafts or levers are provided. Fig. 5 shows the way in which the controller is arranged on large lathes. The shaft running under the tool carriage is an extension of the shaft of cylinder *A*. On this shaft slides a feathered bevel gear that meshes into another gear on the upright shaft seen at the right side of the carriage, and by means of the handle at the top of this shaft the workman can operate the controller wherever the carriage may be.

One decided advantage of systems like the foregoing, in which the variations in speed are obtained by changing the field strength, or the voltage acting upon the armature, or both, is that the regulating qualities of the motor are not destroyed, so that at whatever speed the motor may be set it will maintain this constant without any regard to changes in the amount of work put upon it. With the rheostatic method of control, in which speed reduction is obtained by introducing resistance in the armature circuit, the regulating property of the motor is impaired, so that if it is set for a given velocity, it will accelerate if the load is reduced, and will slow down if the load is increased. As was shown in a previous article, this defect of the rheostatic method renders it practically useless for cases where the work is intermittent. An experiment tried by the Bullock company, which is illustrated in the diagram, Fig. 6, shows that the system is objectionable not only for intermittent work, but even for cases where the load is liable to vary to a considerable extent. A large portion of the work done on lathes for example, is of a kind that renders the load variable, as the size of the cut changes within wide limits. This is the case in taking the first cut on castings and most forged work. In all work of this kind if the speed is adjusted by introducing resistance in the armature circuit, the motor will speed up when the cut is light and will slow down when the cut is heavy. Fig. 6 shows a piece of work in the lathe with the tool taking a light cut when in position *E*, and increasing by steps through the positions *D C B*. By actual test it was found that if the motor was adjusted to run at the proper speed when the tool was in position *E*, it would slow down about twenty-five per cent. when the tool reached position *D*, and on reaching *C*, the motor would stop. The result of this test is shown in Table 1. The extent to which the speed would increase if the motor were adjusted to give the proper speed with the tool in position *B* cannot be very well ascertained experimentally as the velocity would be so great that the tool would be burned away. Table 2 shows what the velocities would be as determined by calculation.

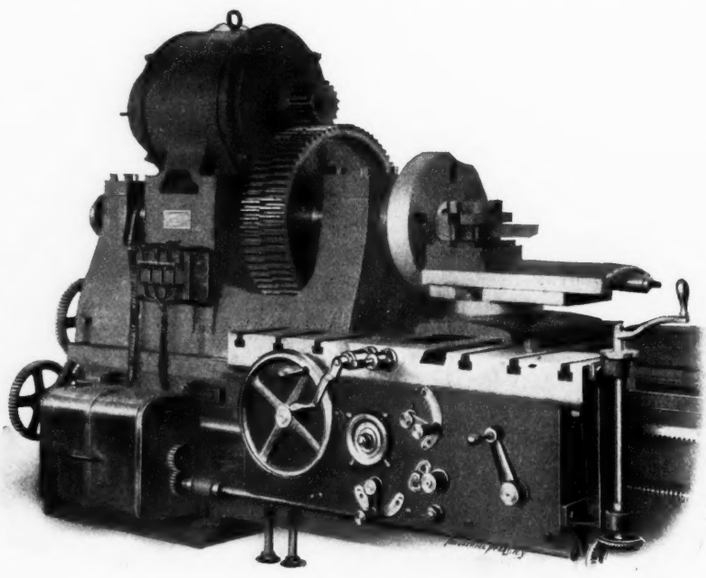


Fig. 5.

From the foregoing it will be seen that any system of variable speed motor control to be satisfactory so far as velocity is concerned, must eliminate entirely the introduction of resistance in the armature circuit, except in passing from one running speed to another.

A NEW FOUR-WHEEL DRIVE FREIGHT TRUCK.

CORNEIL RIDDERHOF.

In MACHINERY for September, 1903, I called attention to the Holson couple-gear motor as being an interesting example of good mechanical arrangement for reducing friction and producing a power transmission of high efficiency. Figs. 1 and 2, reproduced from that issue, show respectively a side view of the assembled motor as used in the hub of a light vehicle and an end view with one of the bevel gears removed. It will be noticed that the motor shaft has a pinion at each end, applying power to the driven member at two diametrically opposite points and dividing the pressure due to driving between both bearings of the motor. Some are bound to call this arrangement a new mechanical motion. Whether this be strictly true or not, it is novel and exceedingly useful and will undoubtedly be applied to many varied purposes.

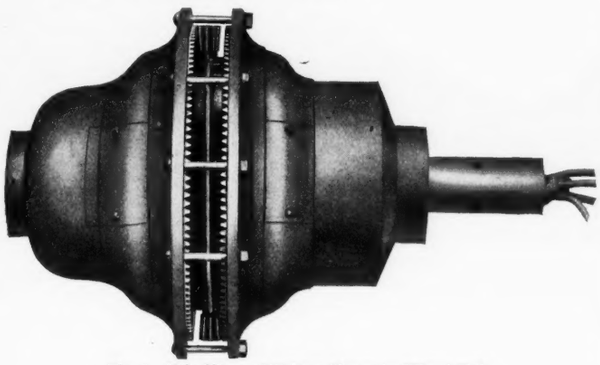


Fig. 1. Side View of Holson Motor in Wheel Hub.

The three-ton freight truck, which it is the purpose of this article to briefly describe, shows one application of the device and I believe it is to such uses as this that it will be most frequently applied. The wheels having the motors within themselves there is nothing to hinder using all four wheels for traction, and this has been done. Fig. 3 is a general view of the truck and incidentally shows that in a vehicle equipped with these motors all wheels can be used for steering without adding complications. This renders the machine capable of being handled in confined places with an ease that must be seen to be fully appreciated and compared with which the complicated bevel gear four-wheel drives that have been used in vehicles with a "central" power plant seem exceedingly crude and impracticable.

Fig. 4 shows one of the wheels with tire and rim removed and shows how near the periphery of the wheel the propelling power is applied. The large bevel gears are 28 inches diameter, 2 inches face, and have 224 teeth, 8 pitch. The pinions on the motor shaft have 9 teeth; giving a reduction of nearly 25 to one, and an equalizing device insures the driving being

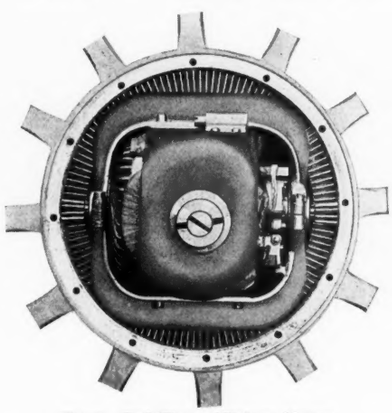


Fig. 2. End View of Holson Motor.

divided equally between both pinions. The four motors are two horse power each and are handled through a drum controller similar to those used in street cars, and brakes on all wheels render the machine safe on any grade. The batteries are 42 exide cells, type M V 15, with a capacity of 200 ampere-hours, and are carried below the platform.

Watching the machine climbing grades with a 7,000-pound load some time since and being informed of the meter readings, I expressed some doubt as to their accuracy, and accordingly a still more severe test was arranged at which I could satisfy myself as to this. An accurate Weston ammeter was secured and connected. Having the instrument on my lap and a note book beside me made it quite convenient to note and record

Fig. 3. Three-ton Truck with four Motors in Wheels.

the readings, and considering the grades, the condition of some of the pavements and the heavy load, I think the performance of the machine quite remarkable. The machine was tried on a 10 per cent. grade and on a very rough cobblestone pavement. Further up the hill (which is four blocks long) the excessive weight caused the front wheels to crush through the pavement but, plowing a deep furrow and scattering the stones right and left, it kept on moving, though slowly. The net weight of the truck is 7,725 pounds, and this added to the load, 9,000

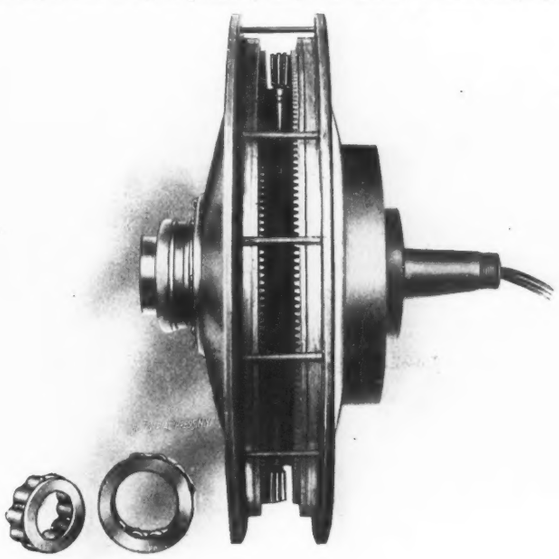


Fig. 4. One of the Wheels of the Three-ton Truck with Tire Removed.

pounds, makes 16,725 pounds; no small matter to push up a grade, and considering that it only took 95 amperes at 80

volts I think the performance quite remarkable. This would indicate $\frac{95 \times 80}{746} = 10.18$ horse power, and assuming an efficiency of the motor of 74 per cent., and of the transmission of 96 per cent, we have $10.18 \times .74 \times .96 = 7.23$ horse power actually expended in pushing this enormous weight up that hill.

Of course speed is an important consideration here, and the truck under this abnormal load (being designed, as before stated, for three tons) moved necessarily slowly, but even at a speed of 1½ miles per hour the actual power, neglecting all resistances excepting that due to elevating this weight, equals $\frac{5{,}280 \times 16{,}725 \times 1.5}{33{,}000 \times 60 \times 10} = 6.69$ horse power.

The exact speed could not be determined as the motors were connected in series and the speed varied continually with changes in resistance due to grade and condition of pavement. With the same load on a level brick pavement the readings averaged 27 amperes at 78 volts.

Although this is the first truck built it appears to be entirely free from those little features of poor design usually so conspicuous in first attempts and I cannot but admire its designer, Mr. Karston Knudsen, of Chicago, for this remarkable vehicle. The steering arrangement is very complete and is worthy of notice. The vehicle may be steered with the front wheels alone; with all four wheels, as shown in Fig. 3; and also when necessary all four wheels may be turned in unison and in the same direction, giving the vehicle a motion in a straight line at an angle to the center line of the body, an action aptly christened the "dog steer" by Mr. Knudsen.

* * *

A SPECIOUS PLEA FOR AMERICAN SHOP SECRETIVENESS.

A gentleman from Philadelphia writes a remarkable letter to *American Industries*, signing it "Self-Preservation," in which he demands in no uncertain manner that visiting foreigners be denied the privilege of visiting American shops. He sees in this generally extended courtesy the means of our industrial undoing, and asks all manufacturers to join hands in a policy of shop exclusion to these polite visitors:

"The growing prominence and popularity of American-made goods in foreign markets has excited the envy of foreign manufacturers to such a degree that it is a well-known fact that they have within the last few years engaged very largely in the business of copying them, and although in most cases the copies are very poor imitations of American products, the low prices at which they are able to sell them has in many instances forced the American maker out of the market, or nearly so, and this, too, in lines that were not known in these markets until introduced and pushed to the front by him.

"If these pirates were only satisfied with making inferior imitations, it would not be so bad, as we could rest assured that the quality of our goods would ultimately give us back our market; but this is not the case. Finding that their inferior productions have not succeeded in many cases in forcing out the American goods, they are sending their representatives to the United States in droves to study our machinery, processes and shop methods, with the end in view of being able to equal our quality of finish as well as imitate our patterns and designs.

"They come to us with plausible stories and polite requests to be shown through our factories, always flattering us with complimentary remarks upon our wonderful growth and enterprise as a great manufacturing nation, and expressing a desire to see how we do it; and this is just the point. After we have in our easy good-natured American fashion shown them *how we do it*, they take the next steamer home and at once proceed to do likewise.

"A case in point as an illustration of their methods. The goods of a certain manufacturer are now imitated in Germany, Sweden and England, but owing to the inferior quality of the imitation they have not succeeded in forcing out the American product; but the Swedish concern, more enterprising than the others, last year sent a diplomatic representative over here to find out how to produce American quality and finish, but the home manufacturer was fortunate enough to discover his mission and of course the gentleman did not gain access to the factory, though he made strenuous efforts to do so. And now we understand that a son of the proprietor of the concern is in the country to try his hand at it. This is only one of many instances, and in many cases they succeed in getting what they are after.

"Another favorite method is to send a man over here to secure employment in a factory manufacturing a line they are copying, and the more menial the position he secures, the better for his purpose, as a sweeper or common laborer who has access to all parts of the plant is never suspected of ulterior motives; but while he is working for his American employer for $1.50 per day he is sitting up nights in his boarding house, making notes and drawings.

"This year, with the World's Fair in St. Louis, is going to be especially prolific in bringing these people to our shores, with their polite requests as foreign visitors to our land of liberty, to be shown through our plants. We cannot too strongly urge the American manufacturer, if he desires to retain the supremacy that he has achieved in the export trade, to politely but *firmly* decline the honor of showing these distinguished foreigners, one and all, through his plant. They know too much already and are learning more every day, and will continue to learn in spite of all we can do; but to give them the information which we have spent years in gaining, freely, as we would a cup of water, is simply suicidal."

Whether a manufacturer shall extend the privilege of inspecting his shop methods to visitors, whether foreign or of the home-grown variety, must be decided individually and chiefly by his sense of hospitality. There are industries in which the advent of a visitor always creates a certain degree of confusion and lost time on the part of the employes (especially if of the female gender), and it is part of a good business policy to generally exclude visitors. But the exclusion of visitors should never be made the policy with the aim of maintaining supremacy. Manufacturing supremacy, in the general sense at least, is not maintained in this manner. We should be very sorry to see American industries pin their faith on such an exploded theory as this. The man who imitates you is never anything but an imitator and so long as you are progressive you can let him imitate safely. In fact it is better to have imitators, for an imitator can rarely or never become a successful competitor. Of course if our peculiar tariff laws are made to work to our undoing that is another matter, and is one that the foreign manufacturer may properly take advantage of.

* * *

PROCESS FOR HARDENING CAST IRON.

A patent has been granted for a process for hardening cast iron, whether in the rough or after machining. It consists essentially of a bath having high heat conductivity, the process of hardening consisting of heating the cast iron pieces and dipping them in the bath in the same manner as pursued in hardening steel. The patent claim reads in part as follows:

"The castings which are to be treated may be completely finished as regards machine work before they are hardened. The casting is first heated to a 'cherry-red' heat; it is then dipped in a bath which consists of a practically anhydrous acid of high heat-conducting power, preferably sulphuric acid of a specific gravity of from 1.8 to 1.9, to which is added a suitable quantity of one or more of the heavy metals or their compounds—such, for example, as arsenic or the like. The preferable ingredients of the bath are sulphuric acid of a specific gravity of approximately 1.84 and red arsenic in the proportions of ¾ pound of red arsenic crystals to 1 gallon of sulphuric acid. The castings may be either suddenly dipped in the afore-mentioned mixture and then taken out and cooled in water, or they may be left in the bath until cool. We find, however, that by dipping the castings in the bath and holding them there for a time, which varies according to the size of the castings, and then completely cooling in water, is quite as satisfactory and produces a material which is just as hard as if the castings were allowed to remain in the bath until cool, and the former method is preferable if a large number of castings are to be hardened, as the bath is thus prevented from becoming overheated. In preparing the bath when sulphuric acid and red arsenic are used, we find that better results are obtained when the crystals are added to the sulphuric acid and the bath is allowed to stand for about a week before using, the reason probably being that the bath becomes more saturated with arsenic compound when the dissolved red arsenic has been long in the sulphuric acid.

"It is found that in castings of comparatively large dimensions the hardening extends completely through the material, and thus the results obtained are far preferable to those obtained by what is known as 'casehardening.' The change which takes place in the metal is in the nature of a molecular rearrangement or recrystallization coincident with an increase in the combined carbon at the expense of the graphitic carbon,

and in this change lies the difference between the results by our bath and ordinary casehardening processes, in which a certain portion of the carbon contained in the materials of the bath is actually given up to the metal.

"It is found that the more rapid the cooling of the metal the harder it will become. For this reason the bath must be of high heat-conducting power, and this requirement is obtained by the use of the ingredients above referred to. The bath must further be practically free from water, as it is found that when the acid contains water in any considerable quantities a steam-cushion is formed between the acid and the metal, which prevents their coming in contact, with the result that the cooling is less rapid, and the iron is consequently not so hard. By having one or more of the heavy metals or their compounds dissolved in the acid the heat-conducting and heat-absorbing powers of the bath are considerably increased."

* * *

THE WORKS OF THE STANDARD PLUNGER ELEVATOR COMPANY.

W. A. WATERMAN.

W. A. Waterman.

The new plant of the Standard Plunger Elevator Company, Worcester, Mass. (Janesville Station), is located on the Boston & Albany Railroad and the Worcester and Southbridge Railway, 3½ miles from the center of the city. The company was organized by Mr. Fred A. Jones, Worcester, Mass., who has been identified with the plunger elevator business for the past twenty years. When the company was formed in September, 1902, they did not have a factory nor the land to build one on, but on the 27th of April, 1903, the largest and best equipped factory in the world for manufacturing plunger elevators was started up in full, with a pay roll of 200 men; and within 15 months from the time the company started, orders had been secured for over 130 elevators, which when installed, were to comprise some of the best and most complete elevator plants that had ever been installed. Recently one of the largest elevator contracts ever let has been secured from John Wanamaker, for 110 elevators. These are for the new Wanamaker stores in New York and Philadelphia. Fifty-two of these elevators are to have long runs for passenger cars, 42 having runs of 184 feet and 10 of 253 feet. Other important contracts for large office buildings in New York, Pittsburg and elsewhere, which call for passenger equipment with long runs, in one building to a height of 282 feet, are further indications of the extent to which the plunger system for elevators is being adopted for high-speed passenger service where safety of life and limb is the first requisite.

The officers of the Standard Plunger Elevator Co. are: W. H. Woodin, New York, President; John Sherman, Hoyt, N. Y., Treasurer; Fred A. Jones, Worcester, Mass., General Manager; Thure Larsson, Worcester, Mass., Chief Engineer, and Edward E. Chase, Worcester, Mass., Purchasing Agent. The main office of the company is at No. 1 Broadway, New York.

The factory is 350 feet long, 150 feet wide and contains a floor space of 80,000 square feet, which includes galleries that are used for a stock room and pattern factory. There is land enough available on the present lot to extend the building to a length of 600 feet. The structure has a very high monitor, so as to let in all the light possible; it is about 55 feet from the floor to the top of the monitor. A handsome building adjacent to the factory contains the Worcester offices of the Company and also drafting rooms, where there are eighteen draftsmen employed at present. There is a separate power house of brick, with limestone trimmings, having floors in the engine room, boiler house and basement of grouting covered with Portland cement. The roof is of structural steel covered with slate, and the whole constitutes a thoroughly fireproof building. The only connection between the power house and the factory, is by a 36-foot square tunnel, waterproof, where all the steam pipes, water pipes and electric cables are laid.

In the power house there are two fire-tube boilers made by the Worcester Boiler Works, operating under a pressure of 150 pounds per square inch. Power is furnished by two 150 H. P. Westinghouse automatic compound engines direct-connected to generators, which furnish the electric power for the factory. The engines are so arranged that they can be worked in separate units or together, as the case may be. No. 1 engine can be united with No. 1 switchboard, or No. 2 switchboard and No. 2 engine can be united with No. 1 or No. 2 switchboard. This arrangement was made so that the engineer can change from No. 1 engine to No. 2 engine, or No. 2 to No. 1 without stopping the engine, which makes it very convenient. After the electric current has passed through the cables to the switchboard, it is passed along to another switchboard and from there it is turned into a Bullock multiple voltage balancer, which enables currents to be obtained of six different voltages, which are as follows: 60, 80, 110, 140, 190, 250. The Bullock four-wire system is used. After the balancer has been started, the current passes through the cables to the basement, then through the waterproof tunnel, up into the factory to the distributing switchboard, where it is turned into any part of the factory and office. The size of the cables that run from the engines to the factory switchboard is 1,000,000 C. M. for the outside wires, and 500,000 C. M. for the two inside wires. The current for the lighting system passes through a balancer in the engine room before it goes to the factory so the voltage can be reduced from 250 to 125, in order to use the Manhattan arc light, which has a voltage of 125. There are about 55 arc lights and these in connection with about 200 incandescent lights, make the factory at night almost as light as day.

In Fig. 1 is an interior view of the factory, looking from the main entrance toward the loading platform and railroad track. It also shows the five-ton high-speed Shaw electric crane. The work of handling elevator material in the past has been done by means of manual labor and by the use of this crane the company can save about fifteen ($15) dollars per day in helpers' wages, to say nothing of the saving of time, which is a very important factor in a manufacturing plant.

The crane has a span of 60 feet, a hoist of 30 feet and can run 350 feet in exactly 60 seconds. It has a test capacity of 15,000 pounds, yet it has lifted a load of 40,000 pounds. This load was not intended to be lifted with the crane, but the chains got hooked to one end of the body of a car, and before anyone realized what had happened, the car and load were hanging in mid-air. The load weighed 70,000 pounds and the car 30,000 pounds. To further show what the crane can do, I will state that I have seen a load of structural iron consisting of 3x3-inch, 3x4-inch, and 4x5-inch angles; also 6, 8, 10 and 12-inch I-beams, making a total weight of 69,000 pounds, unloaded and carried 150 feet in just three hours with the help of two men; also 43 lengths of 10-inch extra heavy pipe unloaded and carried 300 feet in 55 minutes with two men.

In looking at Fig. 1, the method of handling pipe can be easily understood. The view also shows the construction of the factory, the crane posts and also the stock room where all the stock is kept stored. The construction of the whole building can be seen showing the clearstory and the monitor roof; the timber is all southern hard pine.

Fig. 2 shows a view, looking from the railroad track toward

W. A. Waterman, superintendent of the Standard Plunger Elevator Co., Worcester, Mass., was born at North Appleton, Me., in 1871. He served an apprenticeship with the Rhode Island Locomotive Works, Providence, R. I., and has since held positions successively as machinist, assistant foreman, general foreman and superintendent, and has been employed by the Builders' Iron Foundry, Providence, the Providence Engineering Works, and the Plunger Elevator Co., Worcester, previous to going with his present company. He writes, "I had about three years' common schooling and entered my apprenticeship at the age of 14 years. Before that I lived on a large farm. Seventy-five per cent. of my education has been obtained since my apprenticeship by hard study, day and night."

the main entrance; it also shows about 4,000 feet of cylinder and plunger pipe in course of construction. In the center of the floor is a line of pipe which is a part of a cylinder,

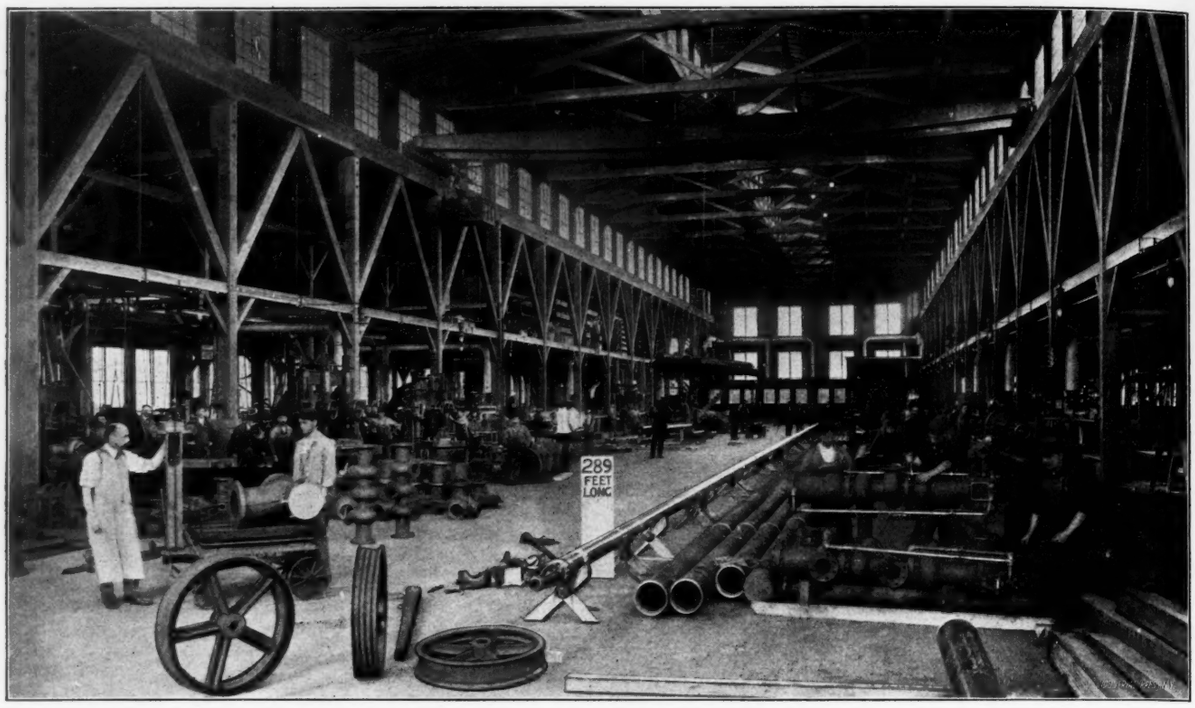


Fig. 1. Interior of Machine Shop of the Standard Plunger Elevator Company. An Elevator Plunger is lined up on the Floor.

that is 240 feet long, and that has been tested at 600 pounds pressure per square inch, and is all ready for shipment.

Fig. 4 shows a hydraulic, pipe-straightening machine, designed by our chief engineer, Mr. Thure Larsson and built in our factory. Two of these are used to straighten the cylinder and plunger pipe. The cylinder pipe is straightened so it will not run out more than 1-16-inch when rotated on centers and the plunger pipe is straightened so it will run within 1-32-inch of true. The reason for straightening the plunger pipe so carefully is because it has to be turned and in order to have the pipe clean up, free from scale, without turning off any more stock than is absolutely necessary, it must be straight to start with.

The hydraulic straighteners are motor driven and the operator can handle the machines to much better advantage than if they were driven by belt. The electric control is placed in front of the cylinder to enable the operator to run the machine and straighten the pipe without changing his position.

Fig. 2. The Opposite End of the Shop, showing Cylinder and Plunger Pipe.

It requires but two men to straighten from 100 to 175 feet of 6- 7- or 8-inch plunger pipe in ten hours.

In connection with the machines is an intensifier that is used to increase the water pressure from 130 pounds (city pressure) to 2,200 pounds pressure per square inch. The cyl-

inder base is 15 inches diameter and the city pressure is not enough to straighten the pipe, so the high pressure has to be used. Sometimes it takes 2,200 pounds pressure per square inch to do the work, which means a pressure of 190 tons to

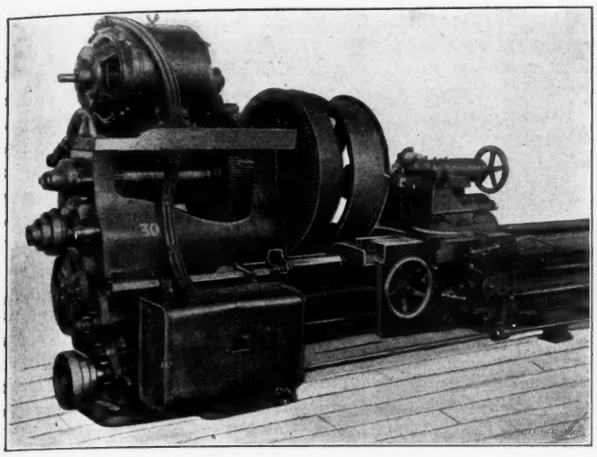


Fig. 3. Motor-equipped Lathe

straighten 12-inch extra heavy plunger pipe. The intensifier is operated by a lever valve, which is placed on top of the cylinder of the machine, and is opened and closed by a lever that hangs down from the valve in front of the operator, so that he can operate both the machine and intensifier without any loss of time.

On the same side of the shop with the hydraulic straightening machines is a group of machine tools consisting of boring mills, planers, lathes and drills. Part of these tools are driven from a line shaft 204 feet long, running at 150 revolutions per minute, power for which is furnished by a 50 H. P. Bullock motor. The larger tools, such as a radial drill and boring mills are independently driven by motors by means of special gearing.

On the opposite side of the shop is the pattern and carpenter shop where eight patternmakers are regularly em-

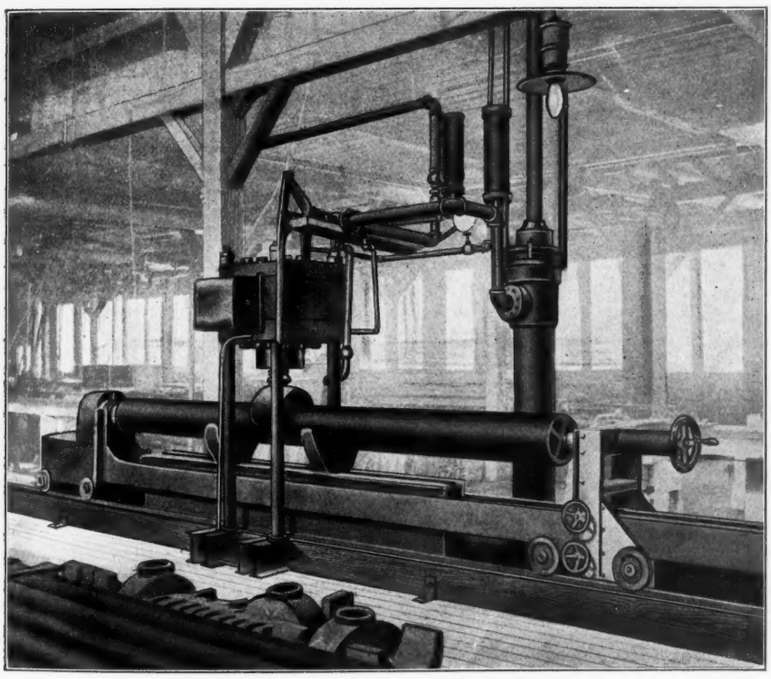


Fig. 4. Hydraulic Straightening Press.

ployed upon patterns for elevator parts. The machinery for this work is of the best and latest design, some of which was made by Whitterby Rug Richardson, Worcester, Mass., and other machines by S. A. Wood, Boston, Mass. We do all our own woodwork, so that we know the best material has been used that the market affords.

Before closing my description of the factory, I would like to call the attention of the readers of MACHINERY (who include not only machinists, but also superintendents, managers and owners of manufacturing plants) to the application of the multiple-voltage system to machine tool driving.

As stated, our factory is equipped with the Bullock multiple voltage system and its advantage over the belt drive for machine tools has proven to be far above expectations. When the motor drive was first talked of we did not anticipate that it would result in a large increase in the output of the various

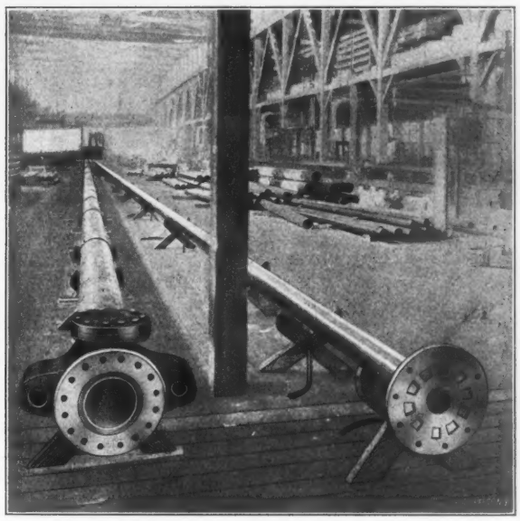


Fig. 5. A 250-foot Plunger and Cylinder for same.

tools to which it was to be applied. It was considered mainly because we did not want any overhead works over the machines on the main floor, which would have interfered with the crane. So we made a careful investigation of the subject and decided to adopt the Bullock system throughout the whole factory. While we finally put in more motor-driven tools than was first intended, our only wish now is that 50 per cent. more of our tools which are not equipped with independent motors had been so equipped at the start, and I must say in justice to the multiple voltage system that our motor-driven lathes will do 50 per cent. more work than belt-driven lathes can possibly accomplish.

Fig. 3 shows a 38 x 22-inch Fish lathe, that was changed over from a belt drive to motor drive. This has a 15 H. P. Bullock motor, with six different speeds, which gives 18 speeds to the lathe instead of 15 by belt, and the operator can get six separate speeds without leaving the carriage or changing his position, by simply turning off the controller handle, when the electric current ceases, thereby causing the machine to stop. To show the advantage of a motor drive on this lathe, I will mention a job that has just been completed. We had three cast iron cylinders, 18 inches diameter and 12 feet long to bore out for a contract in Philadelphia, and when the casting was made in the foundry, they made the core 15¾ inches diameter, so that we had 2¼ inches to bore out. We put in a boring bar 9 inches in diameter with a traveling head 15 inches in diameter with six tools set so as to bore the hole 17¾ inches in diameter. We set the feed at 2-10 inch to a revolution and it went through the whole length without the least trouble. The cutting speed was 25 feet a minute,

but the principal point I wish to make plain is this: That when the test instruments were applied to this motor to see how much power was being consumed, they showed that we were using 9 horse power, whereas the maximum power of the same lathe with a 5-inch double belt was only 6 horse power. This, therefore, goes to show that a 5-inch double belt would not have driven the lathe with the amount of stock being removed, and that we should have been just twice as long in boring these cylinders.

We also do work in a Saunders pipe threading machine with an 8 horse-power motor, that the belt drive could not begin to accomplish. Our F. E. Reed plunger turning lathes with motor drive are doing from 10 to 50 per cent. more work than the belt driven lathes can do with the same operator working on each. In fact, it will take more space than can be spared to write all the results obtainable from our motor driven machines, supplied with the Bullock multiple system. If I were to install the equipment in another factory I should put motor drives on all lathes over 20 inches swing, all milling machines above No. 3, all vertical mills and in fact all machines where heavy work has to be done.

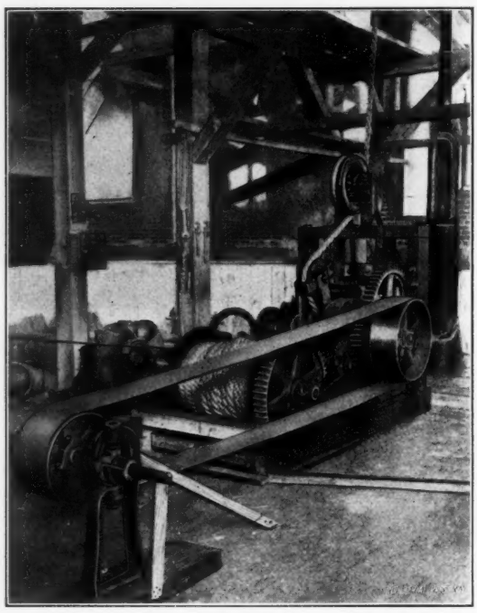


Fig. 6. Jump-drill Machine for Drilling Holes for Elevator Cylinders.

I wish to say a few words about the product that is being manufactured at this plant, although I cannot undertake to relate all the good points of plunger elevators. Everybody, of course, knows what an elevator is for, but I am sure that some readers of this paper do not appreciate why we believe the plunger type is the best type of elevator to have. I will venture the prediction that an elevator suspended by a cable will in 25 years be a thing of ancient history and that the elevator that is pushed from the bottom and cannot fall and kill people will be in use in all buildings where the owners are looking, first, for the safety of the people, second, for speed and durability and third for economical running of the elevator plant.

The first thing to be considered in connection with an elevator is, or should be, the safety of the occupants. When people wish to be carried to any distance above the street floor they like very much to know that they can go up or down with perfect safety. If they are not assured of this they will not go your way.

The second essential thing is the speed and durability. The speed, or what may be called the rapid transit of an elevator, is a factor that must be given due consideration, but the durability of an elevator must be given extra consideration because when a company put in an elevator plant, they do not want to be repairing their elevators ten months out of twelve. I know of one instance where it cost a company $2,000 a year to keep four electric elevators (cable) in repair. Very often three of the four would be out of order for three days at a time, and this particular case is only one of hundreds where cable elevators have proven to be an expensive proposition. When cables have to be replaced, it costs about $1,500 for an 8- to 10-story elevator.

The third essential, the economical running of the elevator, is looked into more seriously, perhaps, by a purchaser, than any other one thing. Our records show that it does not cost over fifty dollars a year to keep an elevator of the plunger type in repair, and I have known of many "Standard Plunger Elevators" that do not cost the owners $20 a year for repairs. The water costs very little, for it is used over and over again until it evaporates or whatever may leak out in the pit-pan. Sometimes the water in the supply or what may be called the discharge tank, will last for two months before it will need to be filled from the city main.

We have not yet been able to determine what the limit is for the successful operation of plunger elevators in high buildings. One that we have installed with a 300-foot run works as well, if not better, than those with a run of 100 or 150 feet. In Fig. 5 is a 6½-inch plunger, 250 feet long, and a 10-inch cylinder for the same, which are part of a contract for the Waldorf-Astoria Hotel, New York City, where there are 17 cable elevators that are to be replaced by Standard Plunger elevators. On the shop floor, Fig. 1, is a plunger 7½ inches in diameter and 289 feet long, which will operate one of 22 elevators placed in the new Hotel Stratford, Philadelphia. Three of these elevators have a run of 289 feet and three a run of 270 feet. These examples of actual installations show what is being accomplished with our plunger elevators for the highest grade passenger service in tall buildings.

The first step in the installation of a plunger elevator is to sink a steel casing, or small caisson into the soil, of slightly larger diameter than the cylinder to provide space for the cylinder itself. The hole is first dug by hand to a depth of about six feet to allow the casing to be set straight; then the drill is put down inside the casing until it comes to the bottom, when the jump-drill machine is started up to operate the drill. Fig. 6 shows one of these machines set up, ready for drilling, which, in this case, is driven by electric motor. At the right of the illustration the drill appears suspended by its rope. When the machine is started it turns the cranks, which throw a lever back on which is a sheave over which the rope passes. The motion of this lever raises the drill a distance of about 26 inches, and when the crank goes over the center the lever is released and the drill drops back and cuts into the ground, and so on, until the drill has worked its way into the ground a distance of about 15 inches below the casing. Then the casing is driven again until it strikes hard bottom, when the drilling is repeated. The hole has to be plumbed about every six feet to make sure of its being straight. In cases where there are ledges we use a rotary machine which works to much better advantage in places like New York City, where it is solid ledge from top to bottom. An annular-shaped drill is used in such cases, which cuts out a solid core of rock. The cutting is done by the pressure of the drill upon steel shot which are dropped into the annular slot that is cut out around the central core.

* * *

The United States consul at Mexico City writes interestingly on rubber culture and its prospects. It appears that large sums of money have been lost by small investors in fake rubber culture schemes, they having been deceived by alluring prospectuses showing the wonderful profits to be gained in a few years. Mr. Conley writes quite discouragingly about the prospects of rubber culture and points out that even if the trees can be made to grow profitably there is ever the prospect of other sources of rubber being discovered, or even that it will be made synthetically from turpentine as camphor is made now. Moreover rubber is not the product of a single species of trees; there are over 1,000 different species of tropical trees from whose sap rubber can be made, and some attempts at cultivation have been made on the unprofitable species. In short, the opportunities for successful rubber culture seem very remote—perhaps the most profitable field is the pockets of the investors.

DETAILS OF THE STANDARD PLUNGER ELEVATOR.

As supplementary to Mr. Waterman's article upon the important new elevator works at Worcester, Mass., the two illustrations, Fig. 1 and 2, herewith, will be of interest, as they show in detail the equipment and principle of operation of the elevators which this firm manufacture. In Fig. 2 is an outline drawing of a "Standard" plunger elevator fitted up complete, with its car, controlling valve, counterweights, etc. When the car is down and the plunger has descended into its cylinder, the plunger is not only supported by the water pressure as supplied to the tube, but also by the pressure due to the displacement of the water by the plunger, or by what may be called the flotation pressure. As the plunger ascends, however, this latter pressure grows gradually less and there is relatively an increasing weight to be taken care of by the counterweight cables, which pass over the pulleys at the top of the elevator shaft. When the car is down these cables add to the weight of the car, and when it is up they add to the weight of the counterweights. This compensating effect of the cables is such as to make the operation of a plunger elevator very successful for high lifts. When the elevator is near the top of its shaft the weight of the cables and counterweights together is sufficient to balance the weight of the car and the upper part of the plunger in addition, which actually places this part of the plunger in tension instead of in compression and removes all liability of the plunger deflecting or buckling under its load, as might be the case on high lifts if the plunger had to support all the load.

The most important part of a plunger elevator, from the operative standpoint, is the controlling valve, and this, as used by the Standard Plunger Elevator Co., is shown in detail in Fig. 1. The inlet or supply pipe is at *S*, the discharge or exhaust pipe at *E*, and at *D* is the connection with the elevator cylinder. The main or operating valve is at *F*, which, in turn, is controlled by the pilot valve at the right of the engraving. The function of the pilot valve is to open or close communication between the left end of the motor cylinder, *M C*, and the supply and discharge pipes, respectively, by means of the small pipe connections at the top of the engraving. The water from the supply pipe is always pressing against the inner faces of pistons *Q* and *R*, which are of different diameters. When water is admitted by the pilot valve to the left of piston *Q* in the motor cylinder, the pressures on each side of this piston will be substantially in balance, and the pressure against *R* will move the main valve *F* to the right. Let the left end of the motor cylinder communicate with the exhaust, however, and the pressure upon *Q* will become unbalanced and the main valve *F* will move to the left.

When the main valve *F* moves to the left, the supply water enters the valve through nozzle *S*, then through nozzle *S'* of the automatic valve, and out through the nozzle *D* to the elevator cylinder, making the elevator car go up. If the main valve is moved to the right, the water in the elevator cylinder will exhaust through nozzles *E'* and *E*, allowing the elevator to come down.

The pilot valve controlling the motion of the main valve is operated from the car by means of a connection with lever *K*, the connection being by a cable at point *X*. If the small valve stem *N* is moved up through lever *K*, links *L* and pinion *P'*, the supply water will enter through the cavity *A* in the pilot valve, and through the small holes in the bushing, pass by the leather-packed piston *O* and through the cavity *C* and pipe *P* into the motor cylinder *M C*. This will cause the main valve to move to the right as before explained. As this valve moves, the pinion *P'* will be revolved by the rack *U* and forced down by means of the nut which is held stationary by the lever *K* and the screw provided at the end of the pinion. This will move stem *N* down so as to shut off communication between the supply and the motor cylinder, thus stopping any further motion of the main stem. If the stem *N* had been moved up a further distance by the operator, the main stem would have traveled a proportionately greater distance before the stem *N* had been moved back sufficiently to close the passage between the supply and the motor cylinder.

If the stem *N* is moved down by the operator, the water is exhausted from the motor cylinder and the main valve *E* moves to the left. This revolves the pinion in the other direc-

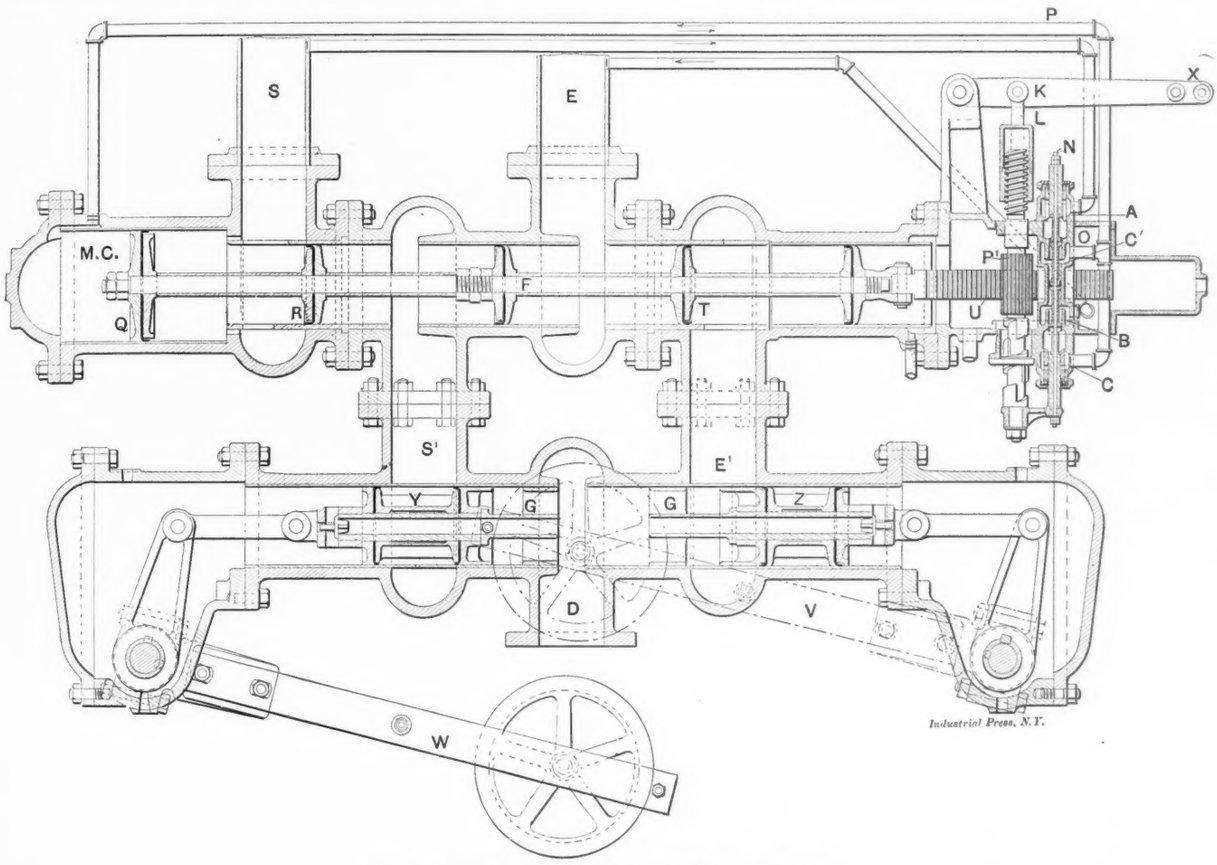


Fig. 1. Controlling Valve of the Standard Plunger Elevator.

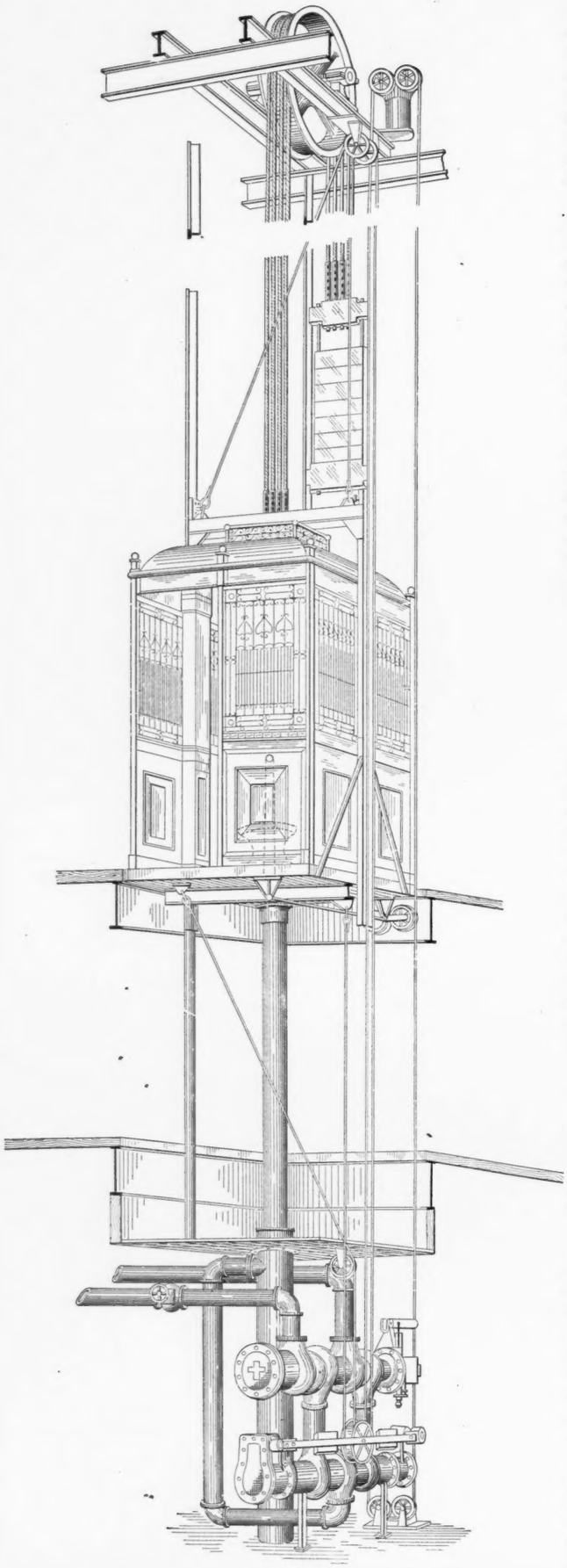


Fig. 2. The Equipment of a Standard Plunger Elevator.

tion, which will then screw itself up on the nut and will move the stem *N* up so as to close the exhaust port from the motor cylinder, thus stopping any further motion of the valve. It will then be seen that the main valve stem will always occupy a position corresponding to the position of the lever *K*, which is controlled by the operator in the car. The catches shown at the lower end of the pinion prevent the lever *K* from being thrown from full open supply to full open exhaust, so as to avoid jumping the elevator off the water when going up or stopping it too suddenly going down.

The action of the automatic stop valve is plainly shown in the engraving. When the elevator approaches the top landing the lever *W* is slowly moved down. This will push the piston *Y* to the right so as to close the passage *S'* and stop the elevator. As the levers *W* and *V* are independent of each other, the closing of the supply opening will not interfere with the exhaust or with the quick starting of the elevator down from the top landing, as the exhaust passage in the automatic valve is fully open until the elevator approaches the bottom landing, in which case the lever *V* will slowly move down and the piston *Z* will close the exhaust opening *E'*.

A weight (not shown) on each lever will automatically open the stop valves as soon as the elevator leaves the top or bottom landing. Should any of the ropes operating the levers *V* and W break, these weights will throw the pistons *Y* and *Z* out to their extreme position so that the sleeves *G* will come opposite the ports and shut down the speed of the elevator. The check valves with small holes through same, shown in the pistons *Y* and *Z*, regulate the speed of the opening of the automatic valves.

* * *

SPINDLE CONSTRUCTION.—2.

SPINDLE BORING AND FINISHING.

HOWARD P. FAIRFIELD.

Crucible steel forgings for lathe spindles, as delivered to the workman, are usually somewhat crooked and may be enough so as to require straightening, but there is usually an excess of stock to finish, and if the centers are located with judgment the forging will finish out. Various ways of locating the centers are in use in different shops. The cut, Fig. 20, illustrates the method in use in one shop. Two "ways," similar to those used in balancing pulleys, are provided and the forging is laid across these. Care must be exercised to have the "ways" placed so the center of what is to be the journal bearing is central with them. The journals are considered to be the most important parts of the spindle and must clean out when to size. The forging is rolled into several positions on the "ways," and is scribed across each end with a scratch block or a surface gage and the center located with a center punch. The center

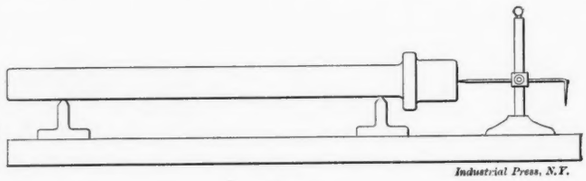


Fig. 20.

drilling and reaming is afterward done under a drill press and the forging is ready for the reduction lathe. With the new high-speed steels the forgings are roughed to approximate sizes and shapes at a rapid rate. A feed of 1-16 inch per revolution is a common standard, with a depth of cut of ⅛-inch and a surface speed of one hundred and twenty-five to two hundred feet per minute. While coarser feeds and depths of cut are possible it is not usual to push the tool much beyond those given, on work of this size.

From the reduction lathe, where the roughing is done, the spindle goes to the special spindle drilling lathe illustrated in Figs. 21, 22, and in section in Fig. 27, in which latter cut the drill appears in connection with its extension tube. In Fig. 29, *c*, is shown a drill with straight flutes and in Fig. 28 one with spiral flutes. Either of these drills may be used as tools in the drilling lathe shown.

In Fig. 21, *a* is the tubular extension of the drill *b*. The tool clamp *c*, is held upon an ordinary lathe carriage and is fed to the work in the same manner as a lathe tool in regular turning operations; *d* is a center rest or guide and serves two purposes. It centers the drill and steadies it to its work and it also furnishes a reservoir through which oil is pumped to the drill as it cuts its way through the blank. As shown in Figs. 21 and 23 *d* is drawn back from the drilling position to show the drill more clearly. In use it is close to the end of the spindle or embraces the end as shown in Figs. 22 and 27. The tank *e* is attached to the carriage by a hook and is towed by it. The oil and chips fall into this tank as they are forced through the tube *a* by the pump pressure. The front end of the tank is made of wire netting and this allows the oil to drain to the lathe bed, the chips being held back by the netting. The lathe bed is fitted with a bottom for holding oil and is furnished with a pump to force the oil to the cutting edges of the drill.

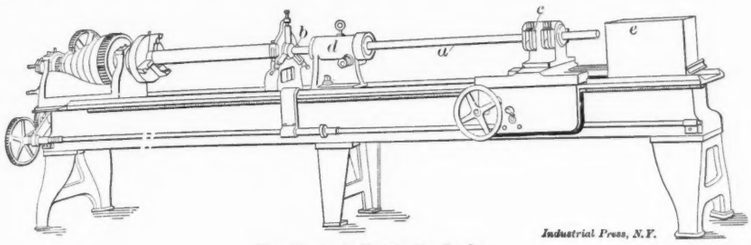


Fig. 21. Spindle Boring Lathe.

By comparing Fig. 28 and Fig. 29, *c*, it will be seen that the oil from the pump strikes the outside of the drill at the rear end of the flutes and is forced along the flat channels on the outer surface until it reaches the cutting end of the drill. The oil then returns by the deep grooves to the hole, where the grooves meet, and thus enters the tube *a*, passing to the tank *e*, taking along at the same time the chips as they are cut from the stock. To ensure a free flow of oil past the cleared end of the drill, the backing at the end of the flute must be ground sharply away, as mentioned in the previous article. Small grooves are ground or milled along the cutting lips to break the chips to a size that can be made to force out with the oil.

While Fig. 21 and Fig. 27 show details of the several parts, Fig. 22 is from a photograph of a spindle drilling lathe in actual use.

When the drilling is completed several methods of finishing the spindle are in vogue, and some of these methods may be of interest. When the hole through the spindle is completed the spindle should be laid aside for a time, that all the strains may relieve. If it is desired that the tapered or center hole be finished before the spindle is ground to dimensions, a hardened and ground plug with a true running center is driven into the rear of the spindle and it is then mounted in a center rest as shown in Fig. 24. The roughing reamer is shown in position to begin roughing the hole to an approximate size and taper. The holder for the roughing reamer is a sleeve with the back end tapped to take an adjustable, threaded center. The shank of the roughing reamer is made to fit loosely in the cylindrical holder and is kept from turning by a pin through the holder and the reamer shank. The rear center hole of the reamer is held upon the threaded center and the reamer is as free to adjust itself as possible, the pin preventing its slipping off the center, and also holding it from turning. The hole is afterward bored to perfect concentricity by using an inside boring tool held as in Fig. 25. To finish the hole a tapered finishing reamer is held rigidly in the tool block and is used to scrape the hole smooth. As little stock as possible is removed by this last operation. The plug in the rear end of the hole is next driven out and the rear end of the spindle is countersunk by using the tool shown at *d*, Fig. 29. This tool is a combined countersink and pilot and is furnished with sleeves that fit nicely into the longitudinal hole.

The test bar shown in Fig. 12 is placed in the tapered

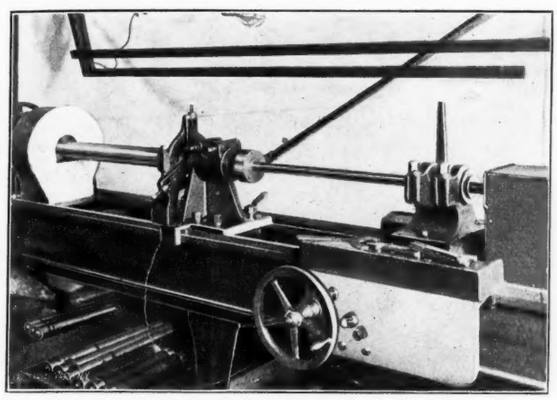


Fig. 22. Drilling the Hole through the Spindle.

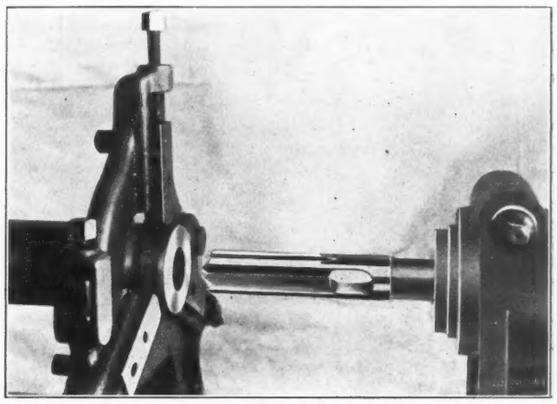


Fig. 23. Showing the Guide drawn back to expose the Drill.

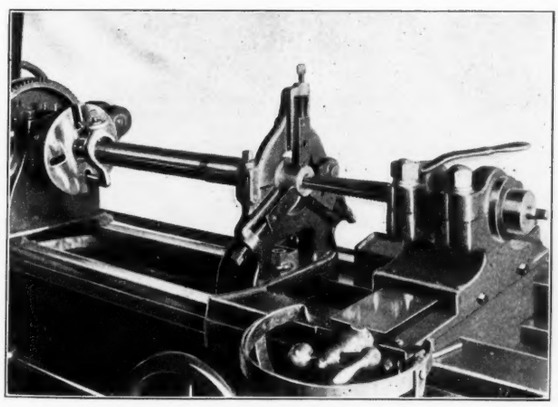


Fig. 24. Roughing out the Tapered Hole.

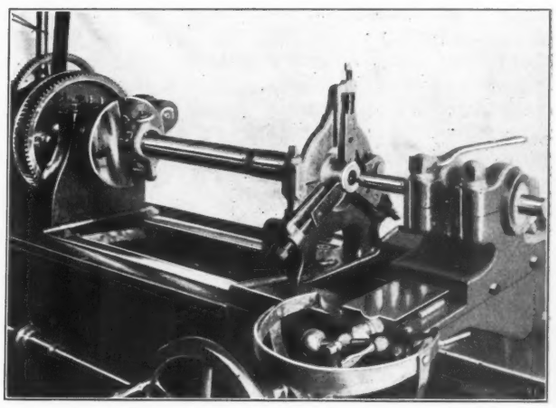


Fig. 25. Truing Hole in End of Spindle with Boring Tool.

hole and the spindle and bar are held on centers in a lathe as in Fig. 26. If now it is found that the test bar shows eccentricity at the front end of the spindle the rear reamed

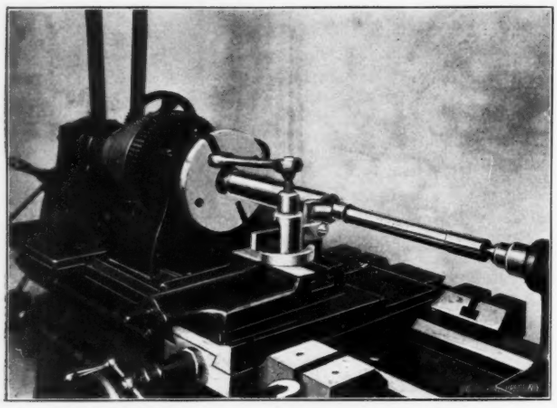


Fig. 26 Accurate Method of Testing Hole in Spindle.

center is scraped until the test bar revolves true when tested with the "indicator." When this is attained it is sure that the center reaming in the rear end is true with the finished tapered hole and when a true running plug is centered in the tapered hole the spindle is in readiness to be threaded, keyseated and ground to fit the several gears, pulleys, bearings, etc., that are in its length. If after these operations are completed the spindle does not test up true, there has been faulty usage in some of the operations. When the face gear,

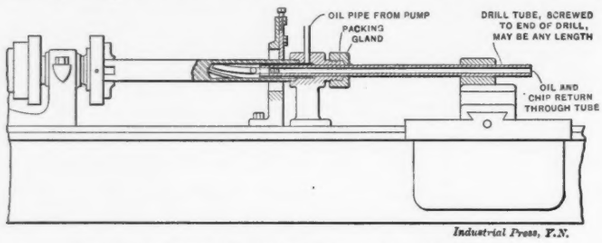

OIL PIPE FROM PUMP
PACKING GLAND
DRILL TUBE, SCREWED TO END OF DRILL, MAY BE ANY LENGTH
OIL AND CHIP RETURN THROUGH TUBE
Industrial Press, N.Y.

Fig. 27. Section of Drill showing means for Oil Circulation.

next to the front bearing, is keyed into place it is necessary to countersink it lightly, and then stake down the shoulder on the spindle hard enough to prevent the gear slipping along the spindle when the lathe center is driven out. While staking this gear on, frequent tests should be made to see that the spindle is not thrown out of truth. The method of finishing that follows is another good way of completing the spindle.

After the long hole is drilled the edges of the hole at each end are chamfered to a 60 degree bearing using as before the special countersink shown in Fig. 29, *a*, and the spindle is turned to leave .007 of an inch on all diameters

Fig. 28.

for grinding, and all keyways and threads are cut except the thread on the nose of the spindle. An arbor such as the one shown in Fig. 30 is then passed through the spindle and tightened into place by the nut shown. This arbor being a standard upon which many pieces may be ground no pains should be spared to make sure that all surfaces are square and true with a center line. All the grinding is done with the spindle mounted upon this arbor, and as the centers in the arbor are lapped to as near perfection as possible, and are so hard that the wear is small, this method would seem to give very perfectly ground surfaces. The tapered hole is finally finished by holding the spindle upon the live center and in a center rest, as described in the former paper. The truth of the tapered hole can be tested with the "Bath" indicator as in Fig. 10, or the indicator point may be used against the inside of the tapered hole if it is desired. This latter method of testing is shown in Fig. 31, but the one shown in Fig. 10 is to be preferred if the greatest exactness is desired. Figs. 10 and 12 just referred to are to be found in the previous article.

Still another method is to rough-ream the center hole and then grind the several bearings upon plugs driven into the ends of the spindle. When the gears, and the cone pulley are in place the spindle is scraped and fitted into its bearings. After this is done the headstock is mounted on the bed of the machine and the tapered center hole is bored out true, with a tool held in the tool block, and then reamed lightly and tested as before until it is true running within the limit of error set. This method is a good one if the spindle has not been changed after it was ground. It is quite likely, however, that some changes have taken place when the gears were keyed on, and the spindle is out of true. If the center hole is then bored with the spindle in its bearings the center hole is true with an imperfect and twisted spindle. Using the lathe tends to relieve the strains put into the spindle by

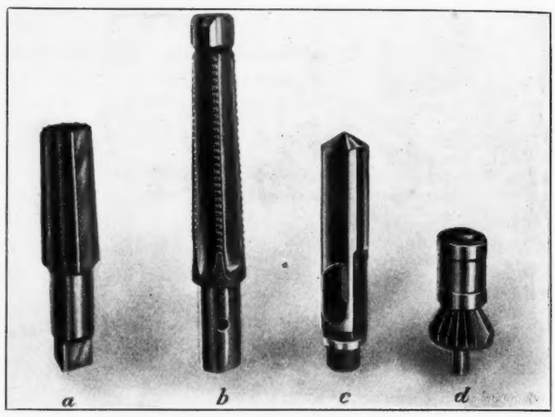


Fig 29. Tools used in Machining the Spindle Hole.

keying and staking on the gears and it assumes its original truth as ground. This throws the tapered center hole out of line with the lathe and results in a poor running live center and one that can only by accident be replaced and run true. By the first two methods, of finishing the center hole and the surface of the spindle true with each other, any changes made when setting up can be detected and remedied at the time of their occurrence.

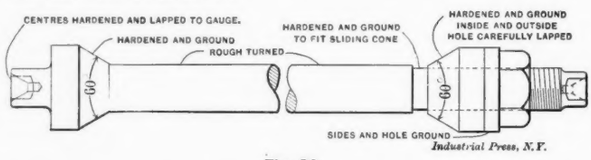

CENTRES HARDENED AND LAPPED TO GAUGE.
HARDENED AND GROUND
ROUGH TURNED
HARDENED AND GROUND TO FIT SLIDING CONE
HARDENED AND GROUND INSIDE AND OUTSIDE HOLE CAREFULLY LAPPED
60
60
SIDES AND HOLE GROUND
Industrial Press, N.Y.

Fig. 30.

The spindles made by the above described methods are usually of sixty point carbon and are unhardened. If greater wearing qualities are desired in the spindle bearings than such spindles will give, low carbon steel is often used for the spindle, and the bearings are then casehardened. The casehardening is done just before the grinding and fitting and is from 1-32-inch to 1-16-inch deep, and only on the surfaces used for the bearings. To accomplish this, the parts

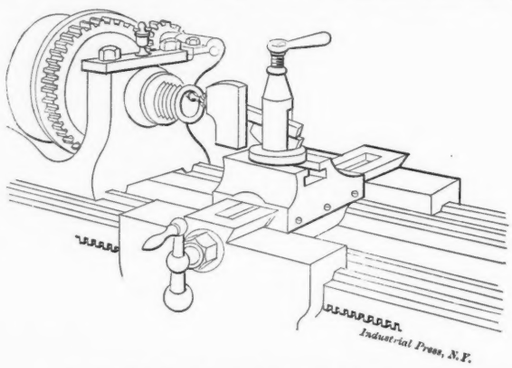


Fig. 31. A Second Method of Testing the Taper Hole.

it is desired to retain soft are copper-plated before treating the surfaces it is desired to harden. This copper-plating prevents the action of the case-hardening compound upon these surfaces and the unplated surfaces only are hardened.

In grinding spindles with a long keyway in the surface, as for instance a drill press spindle, it is usual to fit a strip of hard wood into the keyway, and then shape the wood to the circumference of spindle. When grinding spindles it is desirable to have two grinding machines so set as to have the workman between the two. One machine will have a coarser wheel mounted and will bring the spindles to within .001 of an inch of size; they can then be finished upon the second machine with a finer wheel, leaving a surface that does not need polishing. A feed of from one-quarter to three-eighths inch per revolution should be maintained when grinding, and the spindle should be amply supported by back rests.

* * *

PLANER FOR HIGH-SPEED STEELS WITH QUICK RETURN OF 200 FEET PER MINUTE.

Before the introduction of high-speed steels it was considered good practice to operate a planer at a cutting speed of 20 feet per minute, returning the platen in the ratio of about 4 to 1, or at a speed of about 80 feet per minute. In adapting planers to use high-speed steels, however, the cutting speed has had to be increased, but it has not been possible to maintain the ratio of the return to the cutting speed at 4 to 1, because of the enormous inertia to be overcome at high speeds when the motion of the platen is reversed. This inertia is proportional to the squares of the speeds of the moving parts and is influenced mainly by the high return speed of the platen and the high speeds of the belt pulleys, which must be reversed at each stroke of the planer.

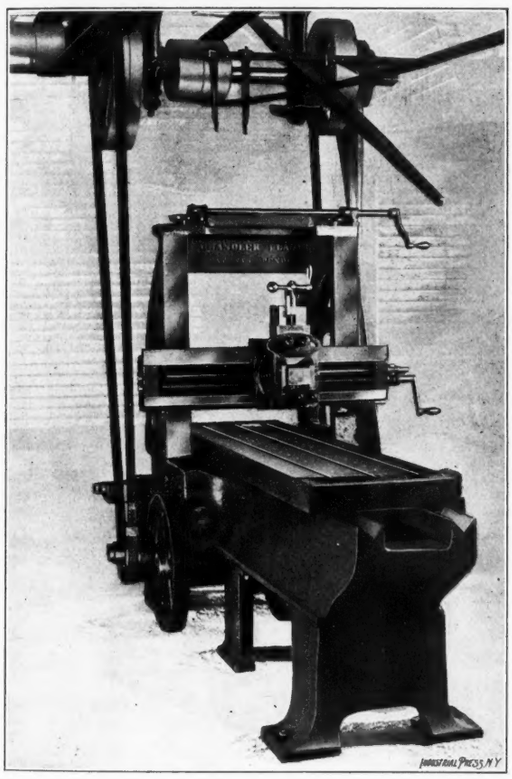


Fig. 1. The Chandler Planer, which runs at a Cutting Speed of 60 feet per minute, returning at 200 feet per minute.

If the planer were cutting at the rate of 20 feet per minute and returning at 80 feet, the inertias of the platen during the cutting and return strokes would be in the ratio of 400 to 6,400. But if the cutting speed were increased to only 25 feet per minute, and the return were maintained at 4 to 1, the inertia during the return would be represented by the large increase of from 6,400 to 10,000. Hence it is that while the cutting speeds of planers have been somewhat increased to adapt them to high-speed steels, it has been necessary to keep the return speed at somewhere near the constant figure of 80 feet per minute.

In view of these facts a planer now in operation in the shops of the Chandler Co., Ayer, Mass., is of unusual interest because it not only runs at a cutting speed high enough to severely tax a Novo steel tool, but maintains its ratio of 4 to 1 for the return speed, without any difficulty whatever. The machine is the invention of Mr. D. L. Chandler, of the Chandler Co., and has been in operation several months, during

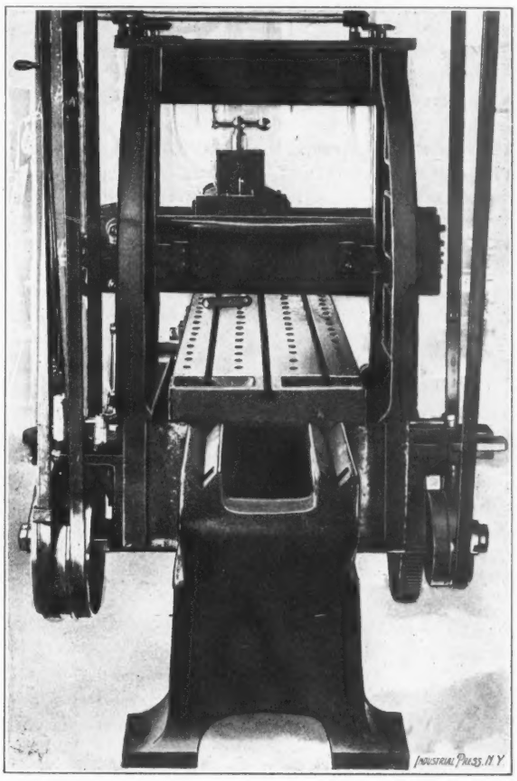


Fig. 2. Rear View showing the three Driving Belts. The one at the extreme left is for the Cutting Speed; the next is for reversing the Platen and the one at the right for the quick return of Platen.

which time it has been subjected to all kinds of rough usage and hard work, with a view to discovering its weak points, should any develop, before placing the planer on the market.

The planer was designed to operate at a cutting speed of 50 feet per minute and to return, as stated, in the ratio of 4 to 1, or at speed of 200 feet per minute; but we are informed that it had been speeded to cut at nearly or quite 60 feet per minute, returning at 200 feet. At these high speeds the platen runs so smoothly that a 6-inch bolt rides upon the platen on a 1⅜-inch head with less disturbance to its equilibrium than is created in slow-running planers with the ordinary style of drive.

The planer is a 24 x 24-inch machine driven by 1½-inch double belts. The writer had an opportunity to time it under actual test, while taking a cut over the surface of a bar of machinery steel 4 feet 4 inches long and 4 inches wide. A tool of Novo steel was used and the cut taken was approximately 5-32-inch deep, with 5-32-inch feed. The time consumed was 3 minutes and 50 seconds, and at the conclusion the tool was somewhat the worse for wear. Under so heavy a cut the speed of the planer was probably somewhat below normal, owing to the slipping of belts. Another job—surfacing cast iron—consisted in roughing out a table 16 inches wide by 5 feet 4 inches long in 11½ minutes and finishing the same with a second cut, taking a broad chip, in 6 minutes.

This important advance in planer speeds is secured by mechanical means that are extremely simple and apparently lead to no complications likely to call for frequent repairs. In fact, we believe that because of the easy reversal of the platen the repair charges will be considerably reduced rather than otherwise.

The principle of the planer is the employment of three belts, one for driving, when cutting, one for reversing, and one for

running the platen back at high speed. As the platen approaches the end of the cutting stroke, the tappet encounters an incline on the dog and is lifted to a position which throws off the cutting belt and throws on the reversing belt, running at a speed that will most effectively reverse the cutting movement of the platen. Thus far, except in details of construction, there is nothing new. The two belts are shifted practically as they are in planers of other makes.

As soon as the platen starts back on its return stroke, however, the tappet encounters a second incline on the dog and is further elevated, throwing off the reversing belt and throwing on the high-speed return belt, which remains in action until near the end of the return stroke, when the tappet encounters a two-step dog, which, on the first step, throws off the high-speed return belt and throws on the slow return or reversing belt. The second step of the dog then throws off the reversing belt and throws on the cutting-speed belt.

The cutting-speed and reverse belts are on the front side of the planer, as in the ordinary type, and the high-speed return belt is on the opposite or rear side of the machine. The arrangement of the belts, pulleys and cams is clearly shown in the line engraving in Fig. 3. At the left of the engraving are two loose pulleys and one tight pulley and on the same shaft at the right are the tight and loose pulleys for the high-speed belt. The two belt shifters at the left are controlled by an oscillating cam having two slots for the rolls, *A*, *B*, attached to the short arms of the shifters. This cam is connected with the sliding cam at the right by the rod *R* so that the two move in unison.

Starting with cam *D*, and with the cutting-speed belt on the tight pulley, as shown, movement of cam to the left causes roll *A* to ride up on surface *a*, *a'*, shifting belt to loose pulley, where it remains until the cam again returns to this point. In the meantime roll *B* travels on surface *b*, *b'*, causing the reversing belt to shift to the tight pulley, where it remains momentarily, and then shifts back to the loose pulley again as the roll passes over the cam surface from *b'* to *b''*. While this belt is being shifted back to the loose pulley, however, the curved part of cam *E* comes into action and shifts the high-speed belt onto its tight pulley, the roll *C* being in contact with cam surface *c*, *c'* during this motion. When the platen finally reaches the other end of its stroke these successive motions occur in the reverse order and the platen is finally carried back to its original position by the slower cutting-speed belt. The speeds, as laid out for the first planer, were 50 feet cutting speed (afterward changed to about 60 feet); 74 feet reversal speed and 200 feet return. For short-stroke work, or any work requiring a particularly accurate stop, the quick-return belt may be thrown out of action entirely by simply raising a latch on the forward planer dog *E*, Fig. 4. The planer then immediately becomes a two-belt planer, with a cutting speed of 50 feet and return of 74 feet per minute.

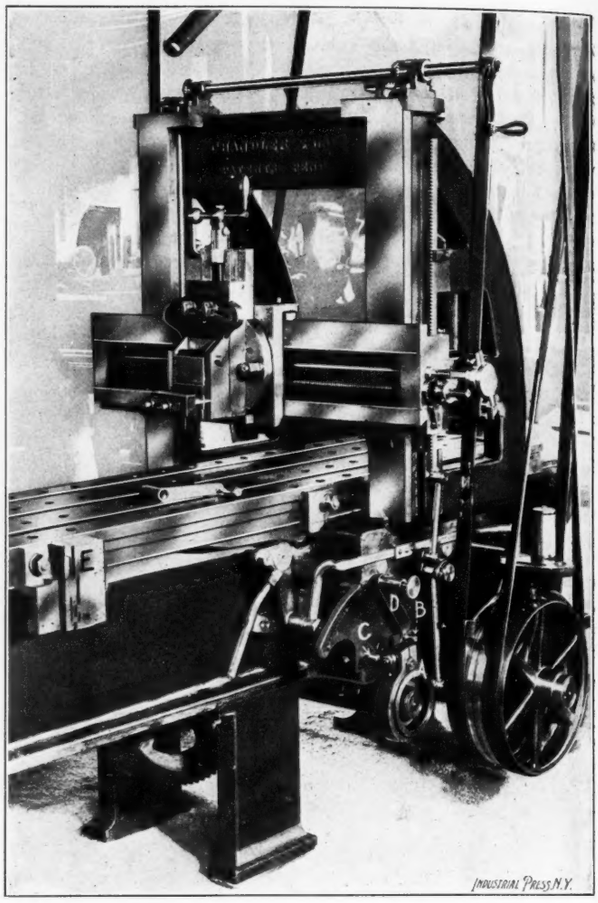


Fig. 4. Side View, showing Details of Variable Feed Mechanism.

It is apparently the case that the Chandler Co. are getting remarkably good results with their planer when running it with two belts only, and they attribute this largely to the use of hardened and ground shafting for the entire driving mechanism. One of the chief difficulties with a planer when pushed to its limit is the cutting of the journals and bearings, owing in part to the high speed of the first or pulley shaft and in

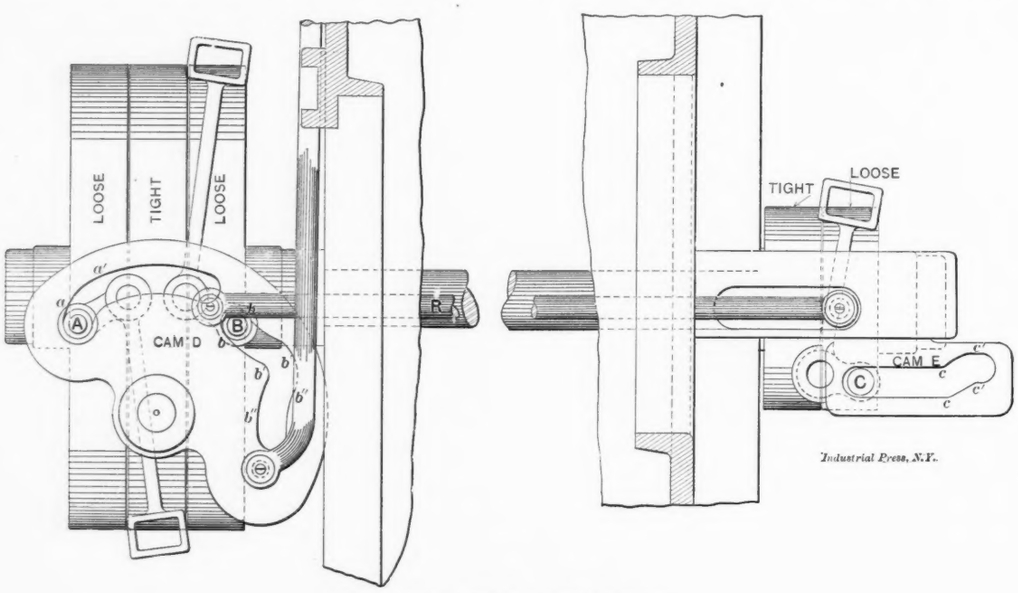


Fig. 3. Details of Belt-shifting Mechanism.

part to the severe stresses that the journals must sustain when the tool is cutting or the platen is being reversed. Mr. Chandler has given much attention to the hardening of large pieces of work and he finds that with hardened and ground shafting running in cast iron bearings, he can maintain smooth journals and bearings indefinitely, under the most severe conditions. This is a feature in machine construction well worth noting, as it not only contributes to continuous running without repairs, but to a small friction loss as well.

Several other features have been introduced, one of which is the feed regulating device. Instead of regulating the amount of feed by moving a wristpin to or from the center of the friction box, the movement of the friction box itself is controlled by a lever, as shown in Fig. 4. A movement of the friction box in one direction is stopped by a stationary pin *C*; but its movement in the other direction is controlled by a pin *B* attached to the lever *D*. The position of this lever is indicated by a marked dial, and it is easily changed to any position, whether the planer is running or stationary, thus placing the feed under the immediate control of the operator, and enabling him to select that which is best adapted to his work.

Another improvement is the arrangement of the feed on the cross rail. This consists of a simple ratchet arrangement by which the pawl is prevented from engaging the ratchet teeth except at the very instant of feeding. The feed handle may therefore be turned freely in either direction, and the tool backed out of the work without the necessity of changing any part of the feed mechanism.

A second planer is now partly completed which will embody some of the improvements suggested by the firm's experience with the first machine. Among these improvements is a speed-changing device for altering the speed of the platen without changing the speed of the driving belts. The full power of the belts, therefore, will be preserved for use at all times, as is not the case where the speed-varying mechanism is in the countershaft.

* * *

EARLY STEAM ENGINES.—2.

In a contribution appended to the article "Steam Engine" in Robinson's "System of Mechanical Philosophy" (1822), James Watt, the father of the steam engine, gave an account of the experiments and reflections which led up to his first invention. This narrative has been republished in Ewing's text book on the steam engine, from which the following abstract is taken, and it will afford an interesting addition to the article upon Early Steam Engines contributed by Mr. A. R. Bell in the last number:

"My attention was first directed, in the year 1759, to the subject of steam engines, by the late Dr. Robinson, then a student in the University of Glasgow, and nearly of my own age. He at that time threw out an idea of applying the power of the steam engine to the moving of wheel-carriages, and to other purposes, but the scheme was not matured.

"About 1761 I tried some experiments on the force of steam, in a Papin's digester, and formed a species of steam engine by fixing upon it a syringe one-third of an inch diameter, with a solid piston, and furnished also with a cock to admit the steam from the digester, or shut it off at pleasure, as well as to open a communication from the inside of the syringe to the open air, by which the steam contained in the syringe might escape. When the communication between the digester and the syringe was opened, the steam entered the syringe, and by its action upon the piston raised a considerable weight (15 pounds), with which it was loaded.

"When this was raised as high as thought proper, the communication with the digester was shut, and that with the atmosphere opened; the steam then made its escape, and the weight descended. The operations were repeated, and though in this experiment the cock was turned by hand, it was easy to see how it could be done by the machine itself, and to make it work with perfect regularity. But I soon relinquished the idea of constructing an engine upon this principle, from being sensible it would be liable to some of the objections against Savery's engine, viz., the danger of bursting the boiler, and the difficulty of making the joints tight, and also that a great part of the steam would be lost, because no vacuum was formed to assist the descent of the piston.

"The attention necessary to the avocations of business prevented me from then prosecuting the subject further; but in the winter of 1763-64, having occasion to repair a model of Newcomen's engine belonging to the Natural Philosophy class of the University of Glasgow, my mind was again directed to it. At that period, my knowledge was derived from Desaguliers, and partly from Belidor. I set about repairing it as a mere mechanician, and when that was done and it was set to work, I was surprised to find that its boiler could not supply it with steam, though apparently quite large enough (the cylinder of the model being two inches in diameter, and six inches stroke, and the boiler about nine inches diameter). By blowing the fire, it was made to take a few strokes, but required an enormous quantity of injection water, though it was very lightly loaded by a column of water in the pump. It soon occurred that this was caused by the little cylinder exposing a greater surface to condense the steam than the cylinders of larger engines did in proportion to their respective contents. It was found that by shortening the column of water in the pump, the boiler could supply the cylinder with steam, and that the engine would work regularly with a moderate quantity of injection. It now appeared that the cylinder of the model being of brass, would conduct heat much better than the cast-iron cylinders of larger engines (generally covered on the inside with a stone crust) and that considerable advantage could be gained by making the cylinders of some substance that would receive and give out heat slowly; of these, wood seemed to be the most likely, provided it should prove sufficiently durable.

"A small engine was therefore constructed with a cylinder six inches diameter, and twelve inches stroke, made of wood, soaked in linseed oil, and baked to dryness. With this engine many experiments were made; but it was soon found that the wooden cylinder was not likely to prove durable, and that the steam condensed in filling it still exceeded the proportion of that required for large engines according to Desaguliers.

"A boiler was constructed which showed, by inspection, the quantity of water evaporated in any given time, and thereby ascertained the quantity of steam used in every stroke by the engine, which I found to be several times the full of the cylinder. Astonished at the quantity of water required for the injection, and the great heat it had acquired from the small quantity of water in the form of steam which had been used in filling the cylinder, and thinking that I had made some mistake, the following experiment was tried: A glass tube was bent at right angles, one end was inserted horizontally into the spout of a tea-kettle, and the other part was immersed perpendicularly in well-water contained in a cylindric glass vessel, and steam was made to pass through it until it ceased to be condensed, and the water in the glass vessel was become nearly boiling hot. The water in the glass vessel was then found to have gained an addition of about one-sixth part from the condensed steam. Consequently, water converted into steam can heat about six times its own weight of well-water to 212 degrees, or till it can condense no more steam. Being struck with this remarkable fact, and not understanding the reason of it, I mentioned it to my friend, Dr. Black, who then explained to me his doctrine of latent heat, which he had taught for some time before this period (summer 1764), but having myself been occupied with the pursuits of business, if I had heard it I had not attended to it, when I thus stumbled upon one of the material facts by which that beautiful theory is supported.

"On reflecting further, I perceived that in order to make the best use of the steam, it was necessary that the cylinder should be maintained always as hot as the steam which entered it; and secondly, that when the steam was condensed, the water of which it was composed, and the injection itself should be cooled down to 100 degrees, or lower, where that was possible. The means of accomplishing these points did not immediately present themselves; but early in 1765 it occurred to me that if a communication were opened between a cylinder containing steam, and another vessel which was exhausted of air and other fluids, the steam, as an elastic fluid, would immediately rush into the empty vessel, and continue so to do until it

had established an equilibrium, and that if that vessel were kept very cool by an injection or otherwise, more steam would continue to enter until the whole was condensed. But both vessels being exhausted, or nearly so, how were the injection water, the air which would enter it, and the condensed steam, to be got out?

"This I proposed, in my own mind, to perform in two ways. One was by adapting to the second vessel a pipe reaching downward more than 34 feet, by which the water would descend (a column of that length overbalancing the atmosphere) and by extracting the air by means of a pump.

"The second method was the one I then preferred, and is the only one I afterward continued to use. In Newcomen's engine, the piston is kept tight by water, which could not be applicable in this new method; as, if any of it entered into a partially exhausted and hot cylinder, it would boil and prevent the production of a vacuum, and would also cool the cylinder, by its evaporation during the descent of the piston.

"I proposed to remedy this defect by employing wax, tallow, or other grease, to lubricate and keep the piston tight. It next occurred to me that the mouth of the piston being open, the air which entered to act on the piston would cool the cylinder, and condense some steam on again filling it. I therefore proposed to put an air-tight cover upon the cylinder, with a hole and stuffing-box for the piston-rod to slide through and to admit steam above the piston to act upon it instead of the atmosphere. (N. B. The piston-rod sliding through a stuffing-box was new in steam engines; it was not necessary in Newcomen's engine, as the mouth of the cylinder was open, and the piston stem was square and very clumsy. The fitting of the piston rod to the piston by a cone was an after improvement of mine, about 1774.) There still remained another source of the destruction of steam—the cooling of the cylinder by the external air, which would produce an internal condensation whenever steam entered it, and which would be repeated every stroke. This I proposed to remedy by an external cylinder containing steam, surrounded by another of wood, or of some other substance which would conduct heat slowly.

"When once the idea of the separate condensation was started, all these improvements followed as corollaries in quick succession, so that in the course of one or two days the invention was thus far complete in my mind, and I immediately set about to verify it practically.

"A large model with an outer cylinder and wooden case was immediately constructed, and the experiments made with it to verify the expectations I had formed, and to place the advantage of the invention beyond the reach of doubt. It was found convenient afterward to change the pipe-condenser for an empty vessel, generally of a cylindrical form, into which an injection played, and, in consequence of there being more water and air to extract, to enlarge the air pump.

"The change was made, because, in order to procure a surface sufficiently extensive to condense the steam of a large engine, the pipe-condenser would require to be very voluminous, and because the bad water with which engines are frequently supplied would crust over the thin plates, and prevent their conveying the heat sufficiently quick. The cylinders were also placed with their mouths upward, and furnished with a working-beam and other apparatus as was usual in the ancient engines; the inversion of the cylinder, or rather of the piston-rod in the model, being only an experiment to try more easily the new invention, and being subject to many objections in large engines."

* * *

The Publication Department of the B. F. Sturtevant Co. is to receive generous recognition in the allotment of space in the new office building at Hyde Park. A portion of the high basement, about 40 feet square, will be devoted to a press room and storage space for paper stock and printed matter. A full equipment of type and of jobbing and catalogue presses will be installed. Immediately above this room and occupying one end of the first story of the same building, will be the offices with a full complement of artists, clerks, etc. The Sturtevant Co. has for several years maintained a printing plant of its own, and is to-day carrying through all the work required in connection with its publications, except the engraving.

THE USE OF MAGNETS IN CONNECTION WITH CRANES.

DR. ALFRED GRADENWITZ.

Magnets have been used for a long time in connection with cranes and hoisting devices, but the danger arising from a careless handling of the goods has been a material drawback to the adoption of similar cranes. On the other hand, certain bodies, such as, for instance, tubes, figured iron, rails, etc., being conveyed by means of an ordinary hoisting device from one place to another cannot always be caught by the tongs fitted to the hoist with the safety required on account of their shape or the way they are stood up. In the case, however, of a magnet being used alone, there is the risk of the current being interrupted from some cause, during the lifting and conveying of the goods, and the men in charge of the crane being seriously injured by the goods falling down.

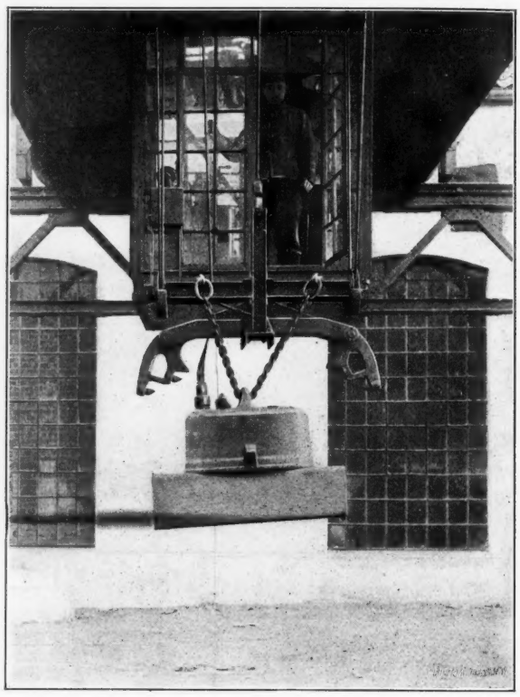


Fig. 1. Lifting Magnet with Tongs for Holding Work when the Current is off.

The ingenious device described in this article has been patented both in Germany, United States and England by the crane-building firm of Ludwig Stuckenholtz, Wetter a/Ruhr. Such magnets as are to be used, for instance, in transporting rails, tubes, etc., are combined with two pairs of grips or bows, closing beneath the magnet. The working of the apparatus is as follows:

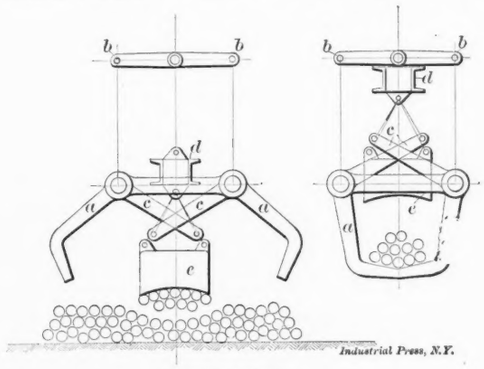
The magnets, being as a rule traversed by no current, i. e., non-magnetic, are dropped on the objects to be transported and next magnetized by switching in the electric current. Simultaneously with the magnet or magnets being lowered, the above bows or grips will open automatically. After the magnet has lifted the body in question, the bows close automatically, when the magnet on the current being switched off will be able to transmit the lifted goods to the bows, this ensuring on one hand a saving of current and on the other hand enabling a transport to be made even above the heads of men working underneath, without any danger to the latter.

The design of the apparatus is shown in the accompanying sketch, where the catching tongs *a* are suspended from the transversal piece *b*, the inward-directed arms *c* crossing one another and being so connected to the vertically movable longitudinal girder *d* (to which the magnet *e* is connected), that the tongs are opened on the girder *d* being lowered along with the magnet, to be closed again as soon as the above parts have been lifted up to a certain height. In Fig. 2 the longitudinal girder *d* is supposed to be dropped, the jaws of the tongs *a* being opened and the magnet having penetrated between them and attracted a number of tubes. In order to facilitate as far as possible the attraction of the magnet and

to maintain it in position, the lower surface of the magnet should have an inward curvature.

Now on the magnet *e* rising again, the tong *a* will close, and on the current being interrupted, the magnet drops the tubes into the closed tongs, when they may be conveyed to the desired place by means of a crane or any other hoisting device, being safe in the hollow of the tongs.

The shape of the tongs may be varied at will according to the kind of goods to be transported. In a special type, the tongs are replaced by a single movable bow whence the goods may slide down easily. This type allows also of the less heavy objects being placed in the bow by hand, after the heavy



Details of Tongs.

goods have been lifted by the magnet.

This exceedingly suitable device allows not only of transporting without any danger any large and massive objects, but also of handling rapidly and safely such goods as ores, scrap iron, pig-iron, as well as any description of small iron, by combining the magnet to vessels opening underneath.

When considering that all the movements, in fact the whole of the loading, are readily controlled and effected by a single man in a minimum of time, it will be seen that this invention opens up for the magnet a nearly unlimited field in connection with the transportation of goods.

As shown by the crane represented in Fig. 1, the inventor has found also other means of combining the magnets with tongs, etc. The crane serves to transport hot and cold ingots. Now as the magnet cannot be used to lift blocks of a temperature higher than 750 deg. C., the catching tongs are made to replace the magnet with these temperatures, the exchange being made most rapidly.

* * *

A DRAGGING DIE DOES NOT STRETCH THE THREAD.

Editor MACHINERY:

In his April article upon tool making Mr. Markham says that a screw may be stretched in cutting by allowing the die to drag the slide along.

When I read that it seemed unreasonable to me, and to test the statement I threaded some studs which are sent you herewith. The studs were all threaded with a die at one cut, in a lathe of about 16 inches swing, from 5-16 rod held in the chuck.

While threading No. 1 the die was allowed to advance at the normal rate without help or hindrance. While threading No. 2 the carriage was drawn along by the die, but while threading No. 3 the die was urged ahead by drawing the tailstock tight against it by means of the carriage.

It is quite easily seen that the lead of No. 2, on which the die was situated, is less than that of No. 1, rather than more, and also that the lead of No. 3 is greater than that of No. 1. It should have been stated that the carriage used moved as easily as the average 16-inch lathe carriage. Notice that increased lead was caused by pushing the die ahead rather than by holding it back.

While this same conclusion can be easily reached by simple reasoning, practice affords the final test after all, so I do not see how the case could be strengthened by argument. I'd like to ask how long a cylinder head would stay tight, if the material commonly used in studs could so easily be given a permanent set?

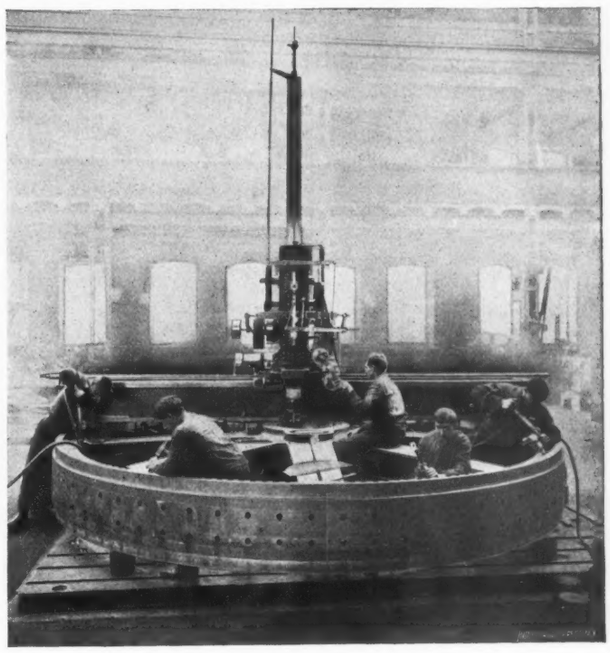
Grand Rapids, Mich. G. M. JOHNSTON.

[We attempted to make an engraving from the threaded pieces sent us by Mr. Johnston, which would show the differences in pitch; but these differences, though of mechanical importance, are so slight from the standpoint of the engraver's art that it is difficult to indicate them in a half-tone illustration. By measuring the pitches of the different screws, we find that No. 1 has 97 threads in a length of 5½ inches; No. 2, 97½; and No. 3, 99 threads. In a 5-16-inch screw, 18 threads to the inch, there should be 99 threads in a length of 5½ inches. —EDITOR.]

* * *

BRINGING THE TOOLS TO THE WORK.

The accompanying illustration, from a photograph sent us by Mr. Frank C. Perkins, shows two pneumatic tools and a portable slotter at work on a rotating field ring at the shops of the Elektricitats-Actien Gesellschaft, formerly Schuckert & Co., Nurnberg, Germany. The floor-plate system, whereby heavy castings are leveled and clamped to massive cast iron floor plates and then machined by electrically-driven portable machine tools, pneumatic tools, etc., has come into use the world over, and this illustration, besides being of interest because from a German shop, affords an instructive example of the advantages of taking the tool to the work. There are



German Portable Slotter.

in all five men performing some operation on the casting—one running the slotter, two using pneumatic tools, besides two who are chipping by hand. The slotter is designed for an unusually long stroke and is essentially a vertical planer. The ram is driven by a train of gears, but the reversal of stroke is obtained through friction clutches instead of by a shifting belt. The clutches are operated by a sliding cam on the front of the head of the machine. The cam receives its motion from a tappet on the ram, which strikes a collar clamped to a vertical rod attached to the cam, at each extreme of the ram's travel. The cam slides between two rollers on a horizontal sliding bar, which in turn operates the clutches.

* * *

A correspondent of the *Scientific American* says that glass can be turned in the lathe and that it can be done better with steel tools than with the diamond. The diamond scrapes and works more slowly, while steel tools can be forced and can be worked at sharper angles, say, 50 or 60 degrees. Moreover, it appears that turning can be successfully done in hand lathes with the tool held over a rest, as in wood turning. The speed should not exceed 15 feet per minute, and slower speed is better. The most effective lubricant is water applied in a continuous stream at the point of the tool. The turning of glass, of course, has its largest field of application in optics, in the making of experimental lenses and similar work.

TOOL MAKING.—8.

SCREW THREADING DIES (Concluded).

E. R. MARKHAM.

Round Dies.—While round dies are oftentimes made solid when they are to be used in roughing a thread preparatory to finishing with another die, a die for cutting screws to a gage or an exact size must be of a form known as an adjustable die, i. e., that may be adjusted to compensate for wear or any desired change of size. The means of adjustment is furnished by splitting the die, as shown in Fig. 22, leaving a thin partition of stock at the outside, as shown in Fig. 23, to prevent the die from springing when hardened. When making this cut commence at the center and cut toward the surface.

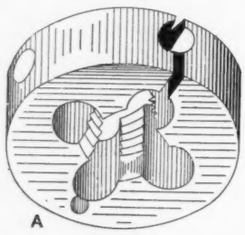


Fig. 22

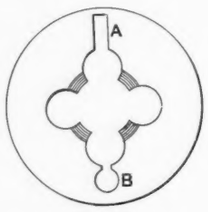


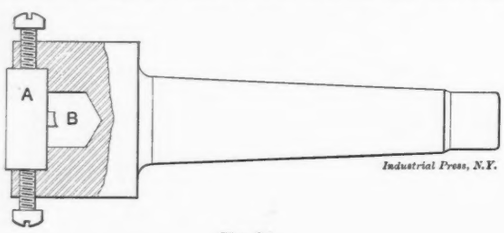
Fig. 23

Industrial Press, N.Y.

Solid dies must be tapped with a tap of the exact size of the screw to be cut, there being no means of adjustment, but the finish tap—or hob—used in tapping adjustable dies is made a trifle large, as when the die is closed to the proper size a slight clearance is given to the heel of the land, which causes the die to cut easier than it would otherwise. The same general remarks in the June issue relative to square dies apply to the round.

After finishing the die and before hardening, run the finish-hob through to remove any burrs and dirt that may be in the thread.

If many round dies are to be made, all of the same outside diameter, it is advisable to use a holder to receive the dies while they are being faced to thickness and drilled and tapped. This holder may be made to screw on the end of the live spindle of the lathe, after the fashion of a chuck, or face-plate, or it may have a tapered end to fit the tapered hole in the spindle, as in Fig. 24, the opposite end being bored out to receive the die, as shown. Screws are used to hold the die in place while it is being machined. An opening somewhat smaller than the one receiving the die is provided, as shown at *B*, Fig. 24, which allows the drills, reamer and tap to pass through the work without striking the holder. Holes may be drilled through the holder to allow the chips to fall out; but few chips are made when drilling one die, and the



Industrial Press, N.Y.

Fig. 24.

holder can be cleaned after each die is removed, so it does not appear necessary to provide these holes, and besides, the holder revolving would throw chips and oil through the holes, and make them a nuisance rather than a help.

The die blank is turned and finished to diametral measurements, and cut a trifle thick. It is then placed in the holder, and one side is faced true and smooth; after which it is removed and reversed in the holder and the opposite side faced to thickness. It is now ready to be drilled and tapped. The other operations are essentially the same as those already described, unless the die is to be made adjustable, in which case the small hole shown at *A*, Fig. 22, is drilled so as to break into the clearance hole.

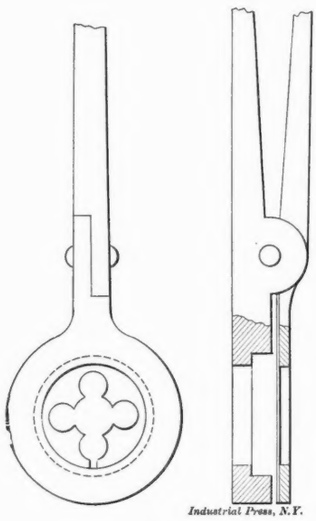
The splitting of the die, to make it adjustable, should be done with a saw or with a narrow file which is cut on the edge. The splitting should not be carried quite to the outside, but should be left as shown in Fig. 23, to prevent the die springing when it is hardened.

Pack-hardening provides an excellent means of hardening dies for cutting threads, but if this method cannot be used they should be very carefully heated in a tube, or some receptacle, where they are protected from the fire. Extreme care should be exercised in heating; the heats should be uniform and no higher than is necessary. Then the die should be grasped with a pair of tongs, Fig. 25, immersed in a bath of lukewarm water or brine, and swung back and forth in the bath in order that the contents may readily pass through the die opening, as this is the portion desired hard.

A very excellent method is to have a holder or a pair of tongs that will take the die as indicated in Fig. 26. In this way the outer rim is protected from the action of the water which, however, has free access to the portion desired hard. The temper should be drawn to a full straw, while the portion between the small hole (*A*, Fig. 22) and the outer edge of die should be drawn to a blue color so that it may spring without breaking when the die is adjusted to cut to size.

After the temper is drawn the thin partition (Fig. 23) may be removed by grinding with a thin emery wheel or a bevel wheel. If it is desirable to have a V-shaped groove to receive a screw point, a common flat-face wheel having a sharp corner may be used.

Fig. 25



Industrial Press, N.Y.

Fig. 26

Before hardening, the diameter of the screw to be cut and the lead should be plainly stamped on the die. This should never be overlooked, as the omission might occasion a vast amount of trouble.

It is customary in shops where the quantity will warrant it to make the blanks on a screw machine, turning them to size with a box tool, and cutting off sufficiently thick to allow of finish on both sides. Where the number does not warrant making them in this manner, a piece of steel may be turned to the desired diameter and the blanks cut nearly off with the parting—cut-off—tool, as shown in Fig. 27.

Spring Dies.—In some shops this form of die is used very extensively, while in others it is entirely unknown. It is, however, easily made and answers the purpose nicely. When it is necessary to work very closely to size it is best to run two dies on the screw—a roughing and a finishing die.

The shape of the die (Fig. 28) is such that a collar is used to keep the cutting edges from springing. On account of its form this collar is known as a clamp collar, and by its use the die may be adjusted to size. Here, again, when many dies are made, considerable time may be saved by using a holder whose shank fits the hole in the spindle of the lathe. The holder is similar to that described for holding round dies, except that the opening is made to accommodate the dies under consideration. As this form of die is made much longer than the others there must be an opening in the back

end somewhat larger than the size of the screw to be cut, so that the length of thread may be no greater than the amount previously mentioned—1¼ times the size of die.

The stock is first turned to size, and cut off to length, then placed in the holder, the large hole in the back end drilled to the desired size, and the end faced true. It is next reversed in the holder, the end squared to length, centered and drilled and tapped. Then it is removed from the holder and milled to form the cutting edges. After drilling and reaming and *before* tapping the end of the hole may be chamfered back for three or four threads.

When milling to form the cutting edges, which for ordinary work should be four in number, use a 45-degree *double-angle* milling cutter. This cutter should be of sufficiently large diameter to produce a cut deep enough for the cutting edges to spring when acted on by the clamp collar. After the cutting with this milling cutter, clearance is given to the chamfered cutting edges by means of a file.

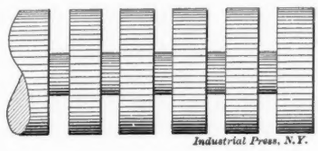


Fig. 27.

For hardening, heat very carefully in a muffle furnace, or in a tube in an ordinary fire, and dip in a bath of lukewarm water or brine. Draw the temper to a full straw color by standing the tool on a hot plate, with the cutting edges uppermost. When the die is drawn sufficiently check in warm oil; a tool checked (when the temper is being drawn) by plunging in cold water is made brittle.

Die holders for use in connection with either round dies or spring dies may be made according to instructions given for releasing holders for holding taps used in screw machines, except as regards size and depth of hole for dies.

The clamp collars can be cut from solid stock, but if many are required drop forgings can be used or a pattern may be made and the collars cast from brass, or cast steel, making the hole small enough to finish to size with a reamer. Then it is drilled and tapped for the adjusting screw, and split, and is ready for use, unless it is thought best to finish the surface. In most shops, however, on account of the cost, it is not considered advisable to finish any surfaces where it is

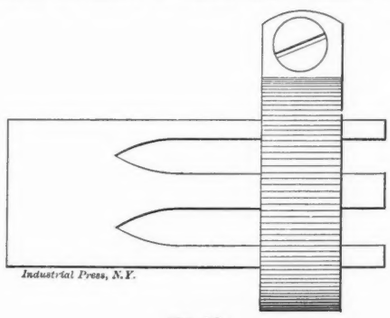


Fig. 28.

not absolutely necessary. Of course they are made smooth enough to prevent chips sticking to them, and so they can be wiped without waste adhering to the surface, but beyond this, polish is not allowable as a rule.

Dies With Inserted Blades.—It is not feasible to attempt to make small dies with inserted blades; but for dies larger than 1¾ or 2 inches in many shops a ring of machine steel or cast iron is made, having slots in which are inserted blades made of tool steel. The first cost of a die may not be any less when made by this method, but the cost of new blades is much less than the cost of a new solid die. Then, again, unless large dies are pack-hardened there is considerable danger of cracking, which is, of course done away with when only the blades are hardened.

The slots to receive the blades should be so made that the front edge of the blade will be radial, as was shown in Fig. 3 in the June issue. The slot must be wider at the bottom than at the top, as shown, in order that the blade may be drawn onto its seating and kept from drawing away from it when in use.

Inserted blade dies may be made either solid or adjustable, as desired. When made solid, they are tapped with a hob the same size as screw to be cut by the die; when made adjustable they should be tapped with a hob a few thousandths of an inch larger than the size of the screw, to provide clearance to the land when cutting. For adjustable inserted blade dies the

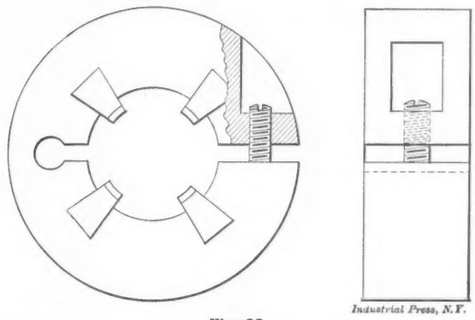


Fig. 29.

method of adjusting for size varies in different shops. Some mechanics consider it best to make them to adjust as shown in Fig. 29, while others claim best results if provided with adjustment as described under adjustable dies, in the beginning of this article. When made as shown in Fig. 29, it is necessary to provide a flat spot on the side to start drilling on, or else the beginner will experience considerable trouble. This flat surface may be made with a chisel, or an end mill may be used in a milling machine, the die held in the vise and the mill fed into the die, as shown in Fig. 30. Should many dies of a size be required a jig must be provided, for use in drilling this hole.

* * *

The quest for a copper-hardening process has absorbed the energies and thought of many misguided blacksmiths and others, who have in some way been led to believe that the discovery of the secret of this so-called "lost art" would immediately place them on some pinnacle of fame and at the same time fill their pockets with a goodly supply of the coin of the realm. Apparently there is some reason for believing that the art of hardening copper is one that never existed save in the imaginations of certain historians who thought that because certain things were done in the copper or bronze age requiring edged tools, there must have been a copper-hardening process. Presumably these ancient people also had iron and steel tools, but all traces of these have vanished, of course, simply because of rust. The New York *Times* quotes from a letter received from Mr. Alexander Del Mar, a mining engineer of New York City, as follows: "No tools of tempered copper that will, for instance, cut rock, have ever been found. I have personally inspected some of the most ancient rock mines in the world in Spain, Cornwall, Pannonia (Hungary), Asia Minor, and elsewhere. The marks upon them are all those of steel tools." It is difficult to see how a practical copper-hardening process could be made to be of any particular commercial value in this age of far cheaper and more plentiful steel. Copper tools could apparently have only one superior characteristic and that is freedom from corrosion, but no one expects to leave fine-edged tools out in the rain and the coarser ones do not seem to suffer badly from a little neglect in that way.

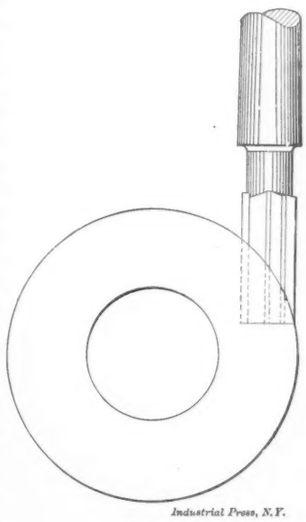


Fig. 30.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JULY, 1904.

NET CIRCULATION FOR JUNE, 1904,—22,764 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 480 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

Mr. Charles H. Haswell, who celebrated his 95th birthday May 23, is undoubtedly the oldest engineer in active practice. While he is perhaps best known to the public as the author of the Mechanics' and Engineers' Pocketbook, he is an engineer of no little reputation and one who has been identified with many notable undertakings for the United States Government. His Pocketbook has reached the enormous sale of 130,000 copies, having passed into the 70th edition, which is now in press.

* * *

It has been freely predicted that the application of electric motors to the driving of machine tools would eventually work a revolution in their design, especially where each tool has its own motor. So far the change has not been much in evidence, save in isolated cases, and this is largely, we believe, because of the limitations of the electric motor and partly because of the conservatism of builders and users of such tools. When users of machine tools cease to demand a range of speeds on, say, a 24-inch lathe, that shall permit any diameter from ½ inch up to the full capacity of the lathe to be handled at the most efficient speed, both for turning and filing, then there will be a better chance for the motor drive to effect its revolutionary work. And the same condition applies to radial drills. With the ideal motor the radial drill would consist of little more than a post and a swinging arm, the latter carrying the spindle, feed mechanism and motor. There would be no splined shafts or bevel gears for transmitting motion around corners since the motor would be applied directly to the spindle, with provision, of course, for the interposition of back gears. This design has already appeared, but is making slow headway. But does the simplest possible method of motor connection apply in the case of the planer? That is, should a reversing motor be connected directly to the screw of a Sellers planer, or the pulley shaft of a spur gear planer, the reversing of the platen being effected by reversing the motor? This latter scheme is being tried, but is it not imposing more on a motor than should consistently be asked, especially on short strokes? The rush of current must necessarily heat such a motor, unless absorbed by resistance coils, which would be wasteful.

* * *

In the course of an address on patents and inventions delivered before the engineering students at Lewis Institute, Chicago, Mr. S. G. McMeen said that the industrial greatness of this nation is in large measure due to the existence of good patent law and to the encouragement which has been given to inventors by its operation. The inventive ability of a people lies not alone in its facility in finding ingenious ways of setting things together to achieve results, but also in its wisdom to see clearly industrial and social needs. In the instance of the inventor who produced the cranberry sorter, every one in the cranberry industry knew the need of sorting so that cranberries for market would contain no soft ones; it required a mental aptitude to see an immediate possibility of invention in the circumstance that when cranberries were spilled down the back steps only the sound ones hopped from step to step, the soft ones stopping early.

In the further course of his remarks Mr. McMeen referred to the abandonment of inventions. An applicant may not secure a patent in this country if his invention has been in actual public use for two years or more before he makes his application. Interesting questions sometimes arise as to whether the use has been really public or might not have been wholly for the purpose of testing the efficiency of the invention by a continued test. A form of sidewalk which had been in use for two years was held not to vitiate the rights of the applicant because, although distinctly in public use, the excellence of its form could only be proved to the inventor by actual trial and could not be considered to be a final test unless continued for a considerable time. In another instance of an article of wearing apparel distinctly not public in its use, a period of two years was held wholly to vitiate the rights of the applicant because very much less than two years should have sufficed to enable him to decide whether the invention was or was not in a proper form for filing his application.

* * *

MIS-DIRECTED INVENTIVE GENIUS.

The driving of marine craft and their design have been fruitful fields for the inventor, but, unfortunately, the results of inventive genius in this direction have been largely negative because certain laws were not understood, or were ignored. For instance, it has been a quite common impression that a vessel can be driven more economically and at higher speeds by a water jet than by a propeller, or paddlewheels. And almost invariably the inventors have proceeded on the assumption that the higher the velocity of the water jet the more effective it would be as a propulsive agent. Hence the general run of these experiments has been with jets of small diameter and high pressure. Needless to say they have invariably failed. The reason is not far to seek. A vessel is propelled by the reaction of a certain volume of water projected backwards. It is easily proven that the larger the volume of water projected backward the greater the propulsive effort transferred to the vessel. It is simply another illustration of the law that action and reaction are equal and in opposite directions. The heavier the gun in proportion to the bullet the less the kick, and *vice versa*. It is the kick that is wanted with the vessel; hence the prime necessity for projecting backwards the greatest possible volume of water—and this can be done with the ordinary propeller more economically, perhaps, than in any other way. Again there is the type of craft known as the water-plane, in which the effort is to ride *over* the water rather than cutting *through* it. In this type there has also been disappointment. A vessel floats simply because of its displacement of an equal weight of water, and it must displace this weight whatever its shape, whether round, square, oblong or flat. The resistants to motion are skin friction, inertia of the displaced water and the air. Beyond a certain ratio it is useless to lengthen a vessel of a given displacement in proportion to its width, for what is gained in the matter of relative speed by displacing the water gently is lost by the added skin friction of such a boat. The displacement is a function of the volume, but the skin friction is a function of the wetted area; the former cannot be changed, but the latter is greatly affected by the shape, and a plane is the worst shape, as it gives the largest proportional wetted surface. Hence what a water-plane craft may gain in the matter of advantageous displacement of the water as it skims over it, is largely or entirely neutralized by the additional skin and wind resistance.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The winner of the international automobile race at Sallburg covered the course of 350 miles in the almost incredible time of 5 hours, 50 minutes and 3 seconds, or almost exactly at the rate of one mile a minute for the entire course. Such exploits put to shame the locomotive, which rarely makes sustained runs at such high speed on smooth rails.

That interesting little periodical, *The Locomotive*, which has been issued monthly since 1867 by the Hartford Steam Boiler Inspection & Insurance Company, will hereafter appear as a quarterly. The quarterly numbers will contain a larger number of pages than the monthly and the matter will be more closely confined to its field, so that the readers will get about the same number of pages of steam engineering matter as heretofore.

A novelty in car construction is that of the Bettendorf oil tank car which has no supporting underframe, the cylindrical shell of the tank forming the sole basis of longitudinal and transverse strength. The upper portion of the tank consists of five sheets joined by circumferential riveted seams, but the lower part is made up of one sheet running the whole length of the tank, thus avoiding a circumferential seam in the part which is subjected to severe longitudinal stresses. The tank has a capacity of 10,000 gallons and the car complete, without loading, weighs 35,000 pounds. To keep the center of gravity low the coupler and draft rigging are mounted in a special steel casting which is riveted to the lower part of the shell and which projects into the interior so that the center line of draft is several inches above the bottom of the tank. This casting also forms the center and side bearings for the truck.

We have received from the Mechanical Engineering Department of the University of Illinois a copy of the fourth edition of their extension of the Dewey Decimal Classification, applied to mechanical and railway engineering. In the Dewey system of indexing the general classes are: 00, General Works; 100, Philosophy; 200, Religion; 300, Sociology; 400, Philology; 500, Natural Science; 600, Useful Science; 700, Fine Arts; 800, Literature; 900, History. The main subdivisions of a class are indicated by numbers, the hundreds place of which indicates the class. Thus Mathematics is 510, which shows that it is in the class of Natural Science, and the divisions of Mathematics are, for instance, 511, Arithmetic; 512, Algebra; 513, Geometry, etc. Mechanical Engineering is 621, showing it is in the class of Useful Science and in the subdivision 620, or Engineering. Steam Engineering is 621.1, and under that we have 621.11 for the Mechanism of the Steam Engine, and again 621.111 for the Reciprocating Parts; 621.112 for Shafts, Journals and Bearings. Locomotives are designated 621.13; details such as smokebox and pipe, 621.1334, etc.

In a report from Beirut, Syria, United States Consul Ravndal writes at length on irrigation and windmills in Syria. He mentions the ancient devices employed for raising water; among them the noria, or wheel with rows of buckets on its periphery. When used in fells or still water these wheels are turned by oxen or mules and sometimes by man power, but in rivers advantage is taken of the current to turn the wheel, floats or paddles being secured to arms so that it acts in undershot waterwheel fashion. This latter system of wheels is seen on a grand scale at Hums, Hamath and all along the Orontes. The wheels are of enormous size; the diameter of some of those at Hamath is 80 or 90 feet. The great advantage of this apparatus is that it is driven by the river itself. Small paddles are attached to the rim, and the stream is turned upon them by a low dam with sufficient force to carry the huge wheel around with all its load of ascending buckets. "There is perhaps," says a distinguished writer, "no hydraulic machinery in the world by which so much water is raised to so great an elevation at so small an expense. Certainly I have seen none half so picturesque or so musical. These wheels, with their enormous loads, slowly revolve on their groaning axles, and all day and all night each one sings a different tune, with every imaginable variation of tone, loud, louder, loudest, down to the bottom of the gamut—a concert wholly unique and half infernal in the night, which, heard once, will never be forgotten"

A consular report calls attention to the investigation and experiments that have been carried on in Germany with superheated steam locomotives. They have established the fact that superheated steam can be used efficiently with locomotives as well as with stationary steam engines. When the greatly superior efficiency of superheated over saturated steam is taken into consideration there seems strong reason to believe that the great success already obtained by the stationary engine will be repeated with the locomotive—that materially superior economy in power will be attained by the use of superheated steam, which will in time come into general use for locomotives. As far as is known there is only one locomotive using superheated steam in America, and it is equipped with a Schmidt superheater and is being experimented with by the Canadian Pacific line. It is believed that it is well worth the while of American technical and railroad men to give careful consideration to the experience obtained by the Prussian State railroad in the utilization of superheated steam on locomotives and to examine the locomotives equipped with the Schmidt and Pielock superheaters that are being exhibited at St. Louis.

In an article, "Chill Rolls," in the *Iron Age*, Mr. B. E. V. Luty says that the standard dimensions of tinplate rolls in this country are 26 inches diameter, 32 inches long in the body and 20 inches diameter in the necks. The depth of chill is about ⅞ inch, but it was formerly only ½ to ⅝ inch. The life of a chill roll is only from 90 to 120 actual working days for tinplate or ordinary sheet rolling, running at 30 revolutions per minute. But many good rolls are broken before they are worn out. The reasons for breaking are somewhat indeterminate, although they may be included under three heads: 1. Casting strains. 2. Excessive pressure on the roll from the material being worked. 3. Heat strains produced in the roll by irregular working. While theoretically the pressure necessary to break rolls by excessive pressure is something enormous, they are frequently broken in this way. It is calculated by the formula

$$W = \frac{4f}{l} 0.0982d^3 \text{ in which}$$

W = load in pounds, applied at the center,
f = fiber strength
l = distance between supports
d = diameter

so that on a standard roll the load applied to the center necessary to break it would be 2,887,000 pounds, taking the fiber strength to be 20,000 pounds per square inch.

THE TAYLOR HYDRAULIC COMPRESSOR AT TAFTVILLE, CONN.

In the September, 1902, issue a brief review was given of some of the systems employed for using the trompe or hydraulic principle for compressing air, and among them was the Taylor 1,000 horse power hydraulic compressor that had recently been installed at Magog, Quebec. A 1,500 horse power Taylor air compressor has since been placed on the Quinebaug River at Taftville, Conn., for supplying compressed air to Norwich, Conn., a city of about 20,000. Its maximum capacity is 12,000 cubic feet of free air per minute compressed to a pressure of 90 pounds. With 23-foot head about 800 cubic feet of water per second is used. A writer in *Compressed Air* says:

"With a 1,500 horse power air compressor is usually associated in one's mind a fine large engine room, well filled with moving machinery, so that the first view of this power house

is somewhat disappointing. A small, low building perched upon one end of the dam, to all appearances the gatehouse and much smaller than many of them, is the only building in sight. Upon entering this one sees a vast quantity of water flowing in from the forebay toward the center and disappearing down a tube some 10 feet in diameter. Suspended above this is a frame supporting several hundred tubes about one inch in diameter and some two or three feet long, their lower ends immersed for a few inches in the water. These are the air tubes and the strong suction action exerted by the water can be easily felt by placing a finger upon the top of one.

"The flow of water is controlled by a set of gates which can be controlled either by a small turbine wheel or by hand. The vertical tube extends downward some 225 feet below the surface of the water in the tail race in order to get the proper submergence for the 90 pounds air pressure required. In the separating chamber is a blow-off pipe several inches in diameter. Normally the bottom of this is sealed by the water in the chamber, but should a surplus of air accumulate the water level falls and the air passes off through the pipe. This stream of air and water is shot some 200 feet and looks as though a small geyser were at work.

"From the compressor a 16-inch cast-iron pipe carries the air to the city of Norwich where it is distributed to several mills and other power users. A very noticeable feature of the air is its absolute dryness. A looking-glass held against a jet of it will not show a trace of moisture. It is claimed to carry less than one-third of the moisture of air compressed by any other means and to have been thoroughly washed and cleansed by its intimate mixture with water during compression. At present the air is chiefly used by the mills in engines of from 100 horse power down. These engines were formerly operated by steam and are generally of the slide valve, throttling governor type, and use much more air than they should, but any engines installed in the future will no doubt be of a construction economical in the use of air. The charges at present are arranged for each individual case, but it is hoped shortly to get upon a meter basis."

THE IMPORTANCE OF A HIGH VACUUM FOR THE STEAM TURBINE.

Abstract from Paper read by Mr. Charles A. Parsons before the British Institution of Electrical Engineers, May 12, 1904.

A good vacuum is of great importance in a turbine, as the expansion can be carried in the turbine right down to the vacuum of the condenser, a function which is practically impossible in the case of the reciprocating engine, on account of the excessive size of the low-pressure cylinder and also of the ports, passages and valves which would be required. Thus in a turbine the benefit derived from a good vacuum is much more than in a reciprocating engine, every 1 inch of vacuum between 23 inches and 28 inches affecting the consumption on an average about 3 per cent. in a 100 killowatt, 4 per cent. in a 500 kilowatt, and 5 per cent. in a 1,500 kilowatt, the effect being more at high vacuums and less at low. It is thus seen how a good vacuum is of importance in a turbine plant, and in this regard it may be well to look into the conditions necessary for obtaining the same. The first point is to avoid all air leaks, and this is easily accomplished in a turbine plant, as there are no packed glands and stuffing boxes to leak. The only places where leakage of air is possible are where the turbine spindle comes out of the cylinder, and here leakage of air is rendered very small by packing the glands with steam, so that any leakage which takes place is steam and not air. The next is to have a suitable condenser, and in this regard sufficient area must be allowed by suitable arrangements of the tubes, and also ample way for the steam between them for proper velocities of the water in the tubes, sufficient supply of cooling water and efficient means of cooling the condensed water so as to keep the air-pump cool, and full provision for extracting, by the air-pump and other means, the inevitable small quantity of air which must leak in. By attention to these requirements it is unnecessary to increase the size of the condenser beyond that used in ordinary practice, so that in the case of the most recent condensers for steam turbines from 10 to 12 pounds steam is condensed per square foot per hour; and at this rate of condensation, vacuums of from 27½ inches to 28 inches, with barometer 30 inches, can be obtained at full load. The amount of cooling water generally allowed is about 50 times the full-load steam consumption, which will increase the vacuum under normal conditions by about ¾ inch or 1 inch over that obtained by the usual 30 times the steam used. If we allow 14 feet total head on the circulating pump due to lift, and for friction in the pipes and condenser, etc.—which in most cases is excessive, especially where the return pipe is sealed—with 50 times the steam consumption in a plant taking 18 pounds steam per kilowatt hour, and assuming 50 per cent. efficiency in the pump and motor, the power used by the circulating pump is only 1 per cent., and with circulating water 30 times the steam consumption it would be 0.6 per cent., a difference of only 0.4 per cent., such a small difference as not to be comparable with the gain of 4 per cent. to 5 per cent. in the turbine by the use of increased circulating water.

With regard to extracting the air, a great improvement has been effected by the use of a vacuum augmentor which has been recently introduced. In it the air-pumps are placed about 3 feet below the bottom of the condenser. From any convenient part of the condenser, preferably near the bottom, a pipe is led to an auxiliary condenser, generally about one-twentieth the cooling surface of the main condenser, and in a contracted portion of this pipe a small steam jet is placed which acts in the same way as a steam exhauster, or the jet in the funnel of a locomotive, and sucks nearly all the residual air and vapor from the condenser and delivers it to the air-pumps. A water seal is provided to prevent the air and vapor returning to the condenser. Thus, if there is a vacuum of 27½ inches to 28 inches in the condenser, there may be only about 26 inches in the air-pump, which, therefore, need only be of small size, the jet compressing the air and vapor from the condenser to about half, or a little less, of its original volume. The small quantity of steam from this steam jet, which is only about 1½ per cent. of that used by the turbine at full load, together with the air extracted, is cooled down and condensed by the auxiliary condenser, which is generally supplied with water in parallel with the main condenser. In this connection it should be observed that condensation in a condenser takes place much more rapidly and effectually if the air is thoroughly extracted than if there is much air present, as the air seems to form a blanket round the tubes and retards the steam getting to them.

CORROSION OF BOILER TUBES.

Journal American Society of Naval Engineers, May, 1904.

In January, 1901, the Bureau of Steam Engineering of the Navy Department directed the Naval Inspector of Engineering Material for the Pittsburg District to carry out a series of tests in order to determine the relative corrodibility of lap-welded Bessemer steel, lap-welded iron, seamless cold-drawn steel and seamless hot-drawn steel boiler tubes. All the samples were secured from the National Tube Company and the tests were conducted in that company's laboratory at McKeesport, Pa.

The tests were conducted in twelve tanks, each tank containing sixteen samples which were taken from the top, middle and bottom of the steel ingots. These samples were shifted about so that at the end of a period of sixteen weeks, each sample should have occupied every position in the tank in which it was placed. The tanks were porcelain lined and were partially filled with distilled water through which compressed air was forced by a compressor. After the tests had been carried on for sixteen weeks the samples were washed, dried, weighed, and photographed to determine the relative corrosion in each case. The samples were made six inches long, from tubes made especially for the purpose, and were all of the same diameter, three inches outside, and of the same gage, No. 9 B. W. G. Each sample was a half of a six-inch tube cut in two longitudinally. Additional tanks were also provided, in one of which eight samples were immersed in a strong alkaline solution—potassium hydrate (KOH).

After each period of sixteen weeks the samples were carefully washed and dried, and weighed. The results were tabulated and an average of the losses per square inch of surface area was made. These averages are as follows:

Average Loss in Grammes.

	After 16 weeks. (1st 16 weeks.)	After 32 weeks. (2d 16 weeks.)	After 48 weeks. (3d 16 weeks.)	After 64 weeks. (4th 16 weeks.)
1. Hot-drawn seamless steel	.3034	.5333	.3510	.5070
2. Lap-welded Bessemer steel	.3147	.4950	.4043	.4945
3. Cold-drawn seamless steel	.3268	.5795	.4595	.5076
4. Charcoal iron	.3326	.5896	.3966	.4893

The difference in the amount of loss in the four classes of tubes is not great, that of the charcoal-iron tubes, which had the greatest loss, being, roughly, 6.3 per cent. more than the loss of the hot-drawn seamless tubes, which suffered the least.

Considering the three grades of the hot-drawn seamless tubes alone, it was found that the average losses per square inch of surface area were:

	After 16 weeks. (1st 16 weeks.)	After 32 weeks. (2d 16 weeks.)	After 48 weeks. (3d 16 weeks.)	After 64 weeks. 4th 16 weeks.
Tubes from the top of ingot	.3205	.5700	.3708	.5213
Tubes from the middle of ingot	.3121	.5339	.3571	.5108
Tubes from the bottom of ingot	.2776	.4960	.3254	.4906

The difference in the losses of these three grades is very marked. At the end of the first sixteen weeks those from the top of the ingot lost 15.4 per cent. more and those from the middle of the ingot 12.4 per cent. more than those from the bottom of the ingot. At the end of thirty-two weeks those from the top of the ingot lost 14.9 per cent. more and those from the middle of the ingot 7.6 per cent. more than those from the bottom of the ingot. At the end of forty-eight weeks those from the top of the ingot lost 15.9 per cent. more and those from the middle of the ingot 9.7 per cent. more than those from the bottom of the ingot. At the end of sixty-four weeks those from the top of the ingot lost 6.2 per cent. more and those from the middle of the ingot 4.1 per cent. more than those from the bottom of the ingot—the loss from the bottom samples being less, probably on account of the lesser amount of impurities and greater density of the metal of the ingot in this part.

Of the three grades of lap-welded Bessemer tubes the average losses per square inch were:

	After 16 weeks. (1st 16 weeks.)	After 32 weeks. (2d 16 weeks.)	After 48 weeks. (3d 16 weeks.)	After 64 weeks. (4th 16 weeks.)
Tubes from the top of ingot	.3686	.5268	.4112	.4966
Tubes from the middle of ingot	.2941	.4826	.3939	.4891
Tubes from the bottom of ingot	.2814	.4756	.4079	.4977

The difference here is even more marked for the top of the ingot than in the case of the hot-drawn tubes. At the end of the first sixteen weeks those from the top of the ingot lost 30.98 per cent. more and those from the middle of the ingot 4.51 per cent. more than those from the bottom of the ingot. At the end of thirty-two weeks those from the top of the ingot lost 10.76 per cent. more and those from the middle of the ingot 1.47 per cent. more than those from the bottom of the ingot. At the end of forty-eight weeks those from the top of the ingot lost .8 per cent. more and those from the middle of the ingot 3.43 per cent. less than those from the bottom of the ingot. At the end of sixty-four weeks those from the top of the ingot lost .22 per cent. less and those from the middle of the ingot 1.72 per cent. less than those from the bottom of the ingot; the great variation in loss of these samples being due probably to a greater amount of impurities of the metal of the ingot in this heat.

The losses per square inch of area were:

	After 16 weeks. (1st 16 weeks.)	After 32 weeks. (2d 16 weeks.)	After 48 weeks. (3d 16 weeks.)	After 64 weeks. (4th 16 weeks.)
Tubes from the top of ingot	.3288	.6166	.4796	.5525
Tubes from the middle of ingot	.3120	.5278	.4451	.4498
Tubes from the bottom of ingot	.3075	.5645	.4451	.5192

When the results obtained from the cold-drawn seamless tubes are investigated, a similar result as in the former cases appears, except that the losses in each series of sixteen weeks is much smaller than in the other cases.

The difference in the losses of these three grades is quite marked; at the end of the first sixteen weeks those from the top of the ingot lost 6.9 per cent. more and those from the middle of the ingot 1.4 per cent. more than those from the bottom of the ingot; at the end of thirty-two weeks those from the top of the ingot lost 9.2 per cent. more and those from the middle of the ingot lost 6.49 per cent. less than those from the bottom of the ingot; at the end of forty-eight weeks those from the top of the ingot lost 7.7 per cent. more and those from the middle of the ingot were equal to those from the bottom of the ingot; at the end of sixty-four weeks those from the top of the ingot lost 6.4 per cent. more, while those from the middle of the ingot lost 13.3 per cent. less than those from the bottom of the ingot.

It appears at first glance that these tubes corroded more uniformly than the two former kinds, but an examination of the averages for the separate tanks shows that this is not the case in the individual tanks. The averages for the individual tanks, both for the lap-welded Bessemer and for the cold-drawn seamless tubes, show the same general results as are shown by the general averages for the three tanks as to the relative losses of the tubes from the top, middle and bottom of the ingot.

No reasonable cause can be assigned for this variation from the results that were obtained in the cases of the hot-drawn seamless tubes, unless it may possibly be due to the hot-swedge rolling and cold drawing to which the metal is subjected. This working which the metal receives may have a greater tendency to reduce the metal of the ingot to a more uniform density throughout than the process of the lap-welded and seamless hot-drawn tubes.

In the additional tank to the water of which the KOH was added at the beginning of the experiments, the average loss for the eight samples, all lap-welded Bessemer steel, was only .0997 grammes per square inch at the end of the first period of sixteen weeks. As this tank contained samples from the top, middle and bottom of the ingot, and the conditions were, with the exception of the alkali, the same as in the other three tanks containing the lap-welded Bessemer steel tubes, the results obtained from it can be fairly compared with the average of these three tanks. The average loss of these tanks was .31500 grammes per square inch of specimen, so that the loss in the alkaline tank was only 31.6 per cent. of that with fresh water. This result indicates strongly the wisdom of keeping the water in boilers slightly alkaline at all times, as a safeguard against deterioration from oxidation. While the result obtained would seem to indicate the advisability of using cold-drawn seamless tubes, looking at it from the point of loss by corrosion alone, yet in making the choice other points must be considered, as, for instance, not only the amount of corrosion but also the nature of the corrosion, whether spread over a large area or concentrated in pits. Some of the tubes showing a large loss may have this loss spread over a large amount of surface and only superficial, while others showing a small loss may have this loss concentrated in three or four pits, which would destroy the value of the tubes much more rapidly than in the other case.

HIGH-SPEED STEAM LOCOMOTIVE TESTS IN GERMANY

From United States Consul-General Mason, Berlin, Germany, Consular Report No. 1972.

In the several reports from this consulate during the past two years describing the conditions and results of the elaborate experiments in high-speed electrical traction which have been conducted on a section of carefully prepared track between Marienfelde and Zossen, near Berlin, repeated reference has been made to the fact that an equally thorough and interesting series of tests would in due course be made with several specially constructed steam locomotives, in order to secure a basis for conclusive comparisons between the two forms of power for high-speed traffic over long distances. The question

to be decided by these deliberate and carefully prepared trials was whether, with the existing conditions of climate, distances between large cities, grades, curves, and the present standard of track and bridge construction in Germany, the speed of express passenger trains could be safely and economically increased to 70 or 80 miles per hour and, if so, whether steam or electricity would prove preferable as a motive power. Would the German "Blitzzug" of the future be hauled by an electric motor or a steam engine so enlarged and improved as to meet the highest requirements of modern railway practice?

The electric motor trials were completed, as will be remembered, during the autumn of last year, with the net result that the two motor cars obtained speeds of 117.32 miles per hour—or nearly 2 miles per minute—without injury to the car or motor, without undue strain upon the track or discomfort to passengers. This upon a straight, nearly level track 14.5 miles long, and of the heaviest and most solid and careful construction, with inside guard rails to minimize the effect of lateral motion at high velocities. But as the railways of Germany involve all the usual variations of grade and frequent curves of a radius as low as 520 yards, any such pace as 117 miles an hour was and must long remain outside the limits of actual practice. It remained for the new locomotives to demonstrate the efficiency of steam up to 80 or 85 miles an hour, the apparent limit of speed development under existing conditions.

Experiments with Steam Locomotives.

The track having been carefully examined and the deteriorating effects of the electric-motor-car trials noted and repaired, the experiments with steam locomotives began about the end of February and were continued until a few days ago. The tests included engines of four different types, each built by a different German firm, or company. In order to make the conditions as nearly as possible those of actual service, the load consisted of six vestibule cars of the standard D type, weighing about 30 tons each, one of which had been equipped with instruments to measure and record speed, oscillation, and the pull exerted by the engine at each part of the run. Each engine was first tested with the full train, then half of it was detached and another series of trials made with three cars only. This latter series was in compliance with the scheme described in a consular report, "The Express Train of the Future," by which it was proposed to divide the fast long-distance passenger-train service into units of three cars each, capable of carrying 100 passengers with all facilities for their comfort by day or night.

The first trials were those of a locomotive built by the Egestorf Machinery Company, at Hanover. It is of the same general model as the "Atlantic" type in the United States—that is, carried on ten wheels, viz., the four-wheeled forward truck, then the two pairs of coupled drivers, and a pair of trail wheels under the cab to sustain the after-portion of the boiler, which is of extraordinary size and large heating surface. This machine, with the train of six cars, attained an average speed of 68.97 miles per hour throughout the run, and with three cars a pace of 79.41 miles an hour.

The second machine, of Grafenstadt construction, is a compound locomotive, likewise of the Atlantic type, in which the cylinders are placed far back and the piston head geared by a short connecting rod to the crank pin of the rear driving wheel. This engine made with the full train a run of 73.32 miles and with three cars 76.42 miles an hour, and showed good results as to fuel and steam consumption.

The third contesting machine was an eight-wheeled compound engine equipped with Schmidt's device for superheating steam. It was designed by Baurath Garbe and built by the well-known firm of A. Borsig, at Tegel, near Berlin. This engine was not built specially for these trials, but is one of a number of the same type which have been constructed by the same firm and supplied for service to the royal Prussian railway administration. The driving wheels are 78 inches in diameter; heating surface, 963 square feet; surface of superheater, 288 square feet; normal working pressure, 176.4 pounds to the inch; and weight, when ready for service, 120,051 pounds avoirdupois. This engine attained with the full train 79.53 miles and with three cars a speed of 84.5 miles an hour, the energy developed being about 2,000 horse power.

The fourth competitor was an engine of a wholly original type, designed by Chief Engineer Wittfeld, of the Prussian railway administration, and built by Messrs. Henschel & Sons, of Cassel. Before being brought to Berlin it was tested on one of the State lines near Göttingen, and since the trials were finished it has been dismantled and shipped for exhibition at the World's Fair in St. Louis. Its most striking peculiarities are that it is so built that the engineer stands in front within a glazed cab like the motorman of an electric car, and both engine and tender are covered with a sheathing of sheet iron with glazed windows and so arranged as to provide a covered passage from front to rear. The engine is carried on twelve wheels, viz., a four-wheel bogie in front and rear and between them the two pairs of drivers, coupled in the usual manner. This arrangement is for the purpose of securing a smooth steadiness of motion despite curves or irregularities of track surface. The engine is of the compound type, the high-pressure cylinder being located midway between the side frames, where its piston connects with an inside crank on the forward driving shaft. The low-pressure cylinders, of which there are two of equal diameter, are external and drive two outside cranks set parallel to each other and on the same side of the axle 90 degrees from the inside crank that connects with the high-pressure cylinder. This secures an even balance between the reciprocating parts, from which important results have been expected. The boiler is, from the European standpoint, enormous, having 2,766 square feet of heating surface, and it is calculated that, with a coal consumption of 2.5 pounds per horsepower hour, it will develop about 1,775 horsepower. It weighs 76.8 tons and cost $23,800. The tender weighs 47 tons and carries 7 tons of coal and 4,400 gallons of water, which it is equipped to take up at speed, as is done on some lines in the United States. At the recent tests this engine slightly surpassed all its competitors, attaining a speed of 79.53 miles per hour with six cars and 85.12 miles with half that number. While, therefore, its speed with the full train was the same as that of the Borsig superheater, the Cassel machine did 0.62 mile better with the light load, a difference so slight that it might easily have been influenced by varying conditions of wind.

This in substance is what is now publicly known concerning the results of these most interesting trials. The comparative advantages of all the contesting engines—their relative consumption of fuel and steam, their general efficiency at high velocities, and their smoothness of movement on curves of different radius—will be known only to the Government experts, until the whole mass of notes and records made during the experiments and subsequently on other portions of the line shall have been formulated and published.

Among the incidental demonstrations made by the tests was the fact that with the pneumatic brakes now in use on German vestibule cars it required a full minute and a distance of 1,093 yards to stop a train of six cars running at 85 miles an hour. German first-class trains are equipped for a maximum speed of 52.8 miles an hour, and their brakes are capable of stopping a train running at that speed on level track within a distance of about 433 yards. If, therefore, any approach to the higher speeds which will be made possible by these new types of locomotives should be adopted, the change will involve important modifications in brakes and signal systems, which are based on present limitations of speed and braking power.

Comparison of Cost of Motive Force.

Pending the preparation and issue of the official report on which the ultimate conclusions will be based, a Berlin engineer, Dr. Reichel, has given some interesting comparisons of cost between steam and electric traction from the standpoint of German practice and illustrated by the recent experiments with both motive forces. A steam train of five cars and a standard locomotive weighs 330 tons, seats 168 passengers, and uses at full speed 1,400 horsepower. The electric train of one motor car and four trail cars weighs 260 tons, seats 180 passengers, and utilizes 1,000 horsepower. Each train and engine costs for initial construction about $100,000. The operating cost of the steam trains is fixed by Dr. Reichel at 12½ cents per 100 seat kilometers, and 11½ cents, or 1 cent cheaper, for the electric train.

THE CURTIS STEAM TURBINE.

From a Paper by W. L. R. Emmet upon "The Steam Turbine in Modern Engineering," read before the June, 1904, meeting of the American Society of Mechanical Engineers.

The general purpose of the Curtis design is to produce results with a reasonable number of simple parts and at moderate speeds, while the Parsons turbine requires a very large number of small parts and the De Laval turbine employs excessively high speeds inapplicable to mechanical purposes without the use of speed reducing gearing.

Mr. Curtis' experiments on steam turbines had been going on for about four years before the General Electric Co. undertook to build any machines for service. At the end of that period, and at a time now about four years ago, the author first became connected with the enterprise, being asked to express an opinion concerning the value of the invention. Other engineers had reported unfavorably, and the discontinuance of work was a possibility. The opinion given was that the invention afforded great possibilities, particularly in the matter of simplicity and economy of production; that the development of commercial machines was justified by the experiments and should be begun at once, and that the development of high degrees of steam economy was to be expected with further experience.

This report led to the beginning of work on a larger scale; the first step being to build a 600 kilowatt unit, which was put into operation at Schenectady in November, 1901. The success of this machine led to the undertaking of commercial work on a large scale, and the experience so far obtained and a careful study of mechanical possibilities led to the adoption for this new work of radically new mechanical designs, applied to bucket and nozzle arrangements similar to those previously used and first recommended by Mr. Curtis. The first machines designed of this new type were a 5,000 kilowatt unit for the Chicago Edison Co., and a 500 kilowatt unit, the first of which was installed at Newport, R. I.

These machines are built with shafts in a vertical position; the total weight of revolving part being borne by a step-bearing at the foot of shaft, and shaft being steadied and aligned by three bearings, one at the top of generator, another near the foot of shaft, and a third between the generator and turbine. Many reasons led to the adoption of this arrangement which involved some untried features, but which afforded very great practical advantages. A careful consideration of designs indicated that the untried features involved little risk of serious difficulty, and experience has shown that this judgment was sound. Some of the important advantages of the vertical shaft type are as follows:

The relative positions of revolving and stationary parts are definitely fixed by the step-bearing.

The stationary part is symmetrical, easily machined and free from distortions by heat.

The shaft bearings are relieved from all strain, and friction is practically eliminated.

The shaft is free from deflection and can be made of any size without reference to bearings, which can be placed where convenient and operated with surface speeds, which would not be practicable with the horizontal arrangement.

These features make possible the use of a very short shaft, and consequently the longitudinal spacing of moving and stationary parts is very little affected by temperature differences.

The turbine structure affords support and foundation for the generator.

The cost of foundations is very small, and the solidity and alignment of foundation is not of vital importance.

Much floor space is saved.

All parts of the machine are conveniently accessible.

Failure of lubrication cannot injure the shaft or other expensive parts.

In the Chicago machine there are two stages, each stage having a single wheel which carries four rows of moving buckets. On the stationary part there are three rows of stationary buckets opposite each group of nozzles used. The shaft is in one piece from the step-bearing to the top of the generator. The wheels are of cast-steel mounted upon it with taper fits. The stages are separated by a cast-iron diaphragm which is fitted with valves which are now operated by hand, but which are being arranged to operate automatically; it being advantageous to constantly maintain a certain pressure relation between the stages.

The step-bearing consists of two cast-iron blocks, one carried by the end of the shaft and the other held firmly in a horizontal position and so arranged that it can be adjusted up and down by a powerful screw. The lower block is recessed to about half its diameter, and into this recess oil is forced with sufficient pressure to balance the weight of the whole revolving element. The amount of oil required is small. About 5 gallons per minute is used in the 5,000 kilowatt machine, but with a good alignment it could be satisfactorily operated with a much less amount. This whole structure is inside of the base, and a packing is used between the oil chamber and the base, so that oil or air cannot get into the vacuum chamber. A small steam pressure is maintained between the sections of this packing, in order that these objects may be accomplished with certainty. In many cases these same step-bearings have been operated with water instead of oil, in which case no packing is necessary, the water being allowed to pass into the base. In some of our latest designs water will be used exclusively; the lower surface of step-bearing being of wood and no packing being provided.

The extreme conditions to which these step-bearings are subjected, and a complete lack of precedent for such designs led at first to many doubts concerning the success of this feature. Experience has, however, shown that these doubts were without foundation. Practically no troubles or interruptions have resulted from this cause, and the step-bearings have shown a ruggedness and stability far beyond our expectations. Many of our turbines have been operated under more or less temporary conditions in incompleted stations, and there have been many accidental stoppages of step-bearing pressure while machines were running. In hardly any cases have such stoppages caused even an interruption of service. The step-bearing surface cuts immediately when lubrication is stopped, but the metal from it is removed very slowly and it has the power of re-establishing itself almost immediately when oil flow is again started. Our policy in adopting the vertical design and putting our dependence in step-bearing was to put all our eggs in one basket and watch the basket. We have now discovered that very little watching is necessary. In our newer designs we are providing a powerful brake, bearing on the lower surface of a chilled iron ring carried by the lower wheel. This brake can be conveniently operated from the outside, and can be used to take the whole weight of the revolving part in case the step-bearing support should fail. In ordinary operation the shoes of this brake will be set about .01 inch below the brake ring. It is thus in a position to receive the revolving part in case the step-bearing support should fail. Another and more important function of this brake is to stop the machine when it is desired to do so. One of the 5,000 kilowatt vertical shaft machines will run for four or five hours after the steam has been shut off, unless load is put upon it or a brake is applied.

THE DE LAVAL STEAM TURBINE.

From a Paper by E. S. Lea presented before the June, 1904, meeting of the American Society Mechanical Engineers.

The velocity of the steam jets in a De Laval turbine varies considerably, owing to change in pressure of the steam before entering the nozzles, to varying exhaust pressure, and to a greater or less degree of moisture or superheat in the steam. The lower limit of this velocity found in general practice might be considered as about 2,000 feet per second, which is obtained at a steam pressure of about 45 pounds per square inch, at an exhaust pressure equal to the atmospheric pressure, and with steam containing 10 per cent. of moisture. The upper limit is found to be about 4,400 feet per second, at a steam pressure of 200 pounds per square inch, at 27.5 inches vacuum, with the steam superheated 200 degrees F.

A certain mathematical relation should exist between the nozzle angle, the velocity of the steam jet, the peripheral velocity of the turbine wheel, and the inlet angle of the buckets. The outlet angle of the buckets should be the smallest possible. Practical considerations limit to a certain degree the attainment of proper angles for the very best efficiency. Thus,

in the De Laval turbine, a nozzle angle of 20 degrees has been established for all sizes of the turbine, the inlet and outlet angles of the buckets are made alike, and are 32 degrees for smaller sizes, 36 degrees for larger sizes. With these angles fixed, and taking into consideration the thickness of the buckets, it will be found that the best theoretical peripheral velocity of the turbine wheel will be about 950 feet per second for a steam jet velocity of 2,000 feet per second, and about 2,100 feet per second for a jet velocity of 4,400 feet per second.

Contrary to popular belief, there are no reasons, either theoretical or practical, to prevent the building of a safe turbine wheel, with a peripheral velocity as high as 2,100 feet per second; only economical reasons have put a limit to it. In the turbines that have been built, the actual peripheral velocity varies between about 1,400 feet per second in the larger sizes, and about 500 feet per second in the smaller sizes.

The diameters of the turbine wheels are such, in relation to the given peripheral velocities, that the speeds run from 10,600 revolutions per minute for the largest size, to 30,000 revolutions per minute for the smallest size. These speeds are reduced approximately 10 to 1, by helical gearing, giving driving shaft speeds of 900 to 3,000 revolutions per minute. A single gear wheel is provided in the smaller types, and in the larger sizes they are double.

The high velocities of the rotating parts of the De Laval turbine create some interesting practical problems. The turbine wheel itself is designed with a factor of safety of about 8 at normal speed. A cross section of the wheel would show the disk to increase in thickness from periphery to center, its profile following a curve so proportioned as to produce uniform radial and tangential stresses, due to centrifugal force, throughout the disk. The buckets are inserted into milled slots in the rim of the wheel.

The stresses vary with the square of the speed and with increasing speed they will gradually increase to a point where the wheel will burst. Provision should therefore be made to prevent serious damage in the event of such an accident. In the De Laval turbine this protection is obtained by reducing the thickness of the wheel close to the periphery, which naturally decreases the strength of the wheel at this point, the stresses here being about 50 per cent. higher than in the rest of the wheel. At normal speed the factor of safety at this point of the wheel is about 5; consequently the wheel will burst here at about double its normal speed, and in such a manner that the rim holding the buckets is broken up into pieces, which, on account of their small size, are unable to do any damage to the wheel case. At the moment the rim leaves the wheel, the stresses in the solid wheel body are considerably reduced, at the same time the wheel becomes unbalanced, and as the clearance between the heavy hub of the wheel and the safety bearings in the surrounding wheel casing is very small, the hub of the wheel will come in contact with the latter, which efficiently act as a brake on the wheel, and bring it to a stop in a short time, as with the buckets gone, the steam has no effect whatever on the wheel. Exhaustive experiments have verified these statements, it having been found that turbine wheels without this decrease in section at the outer periphery, having purposely been speeded up, would burst through the center in two or three heavy pieces, which, at the high velocity, a wheel case of ordinary proportions would not resist. Such pieces have been driven through an experimental wheel case of steel castings, having walls 2 inches thick. With the wheels as made, however, they are perfectly safe, and in the event of the rim being stripped, no damage will result except to the wheel itself.

In this connection is an interesting point concerning the speed regulation of the De Laval turbine. In condensing turbines operating with very high vacuum, the passive resistances are sometimes extremely small, and even if the governor valve throttles the steam considerably below the atmospheric pressure, the remaining pressure may be sufficient, at no load, to increase the speed above the normal. To prevent this speed increase, a second regulating mechanism is provided, the purpose of which is to decrease the vacuum in the wheel case. A small valve, operated by the governor, admits air to the wheel case, after the governor has closed the valve in the steam line. This raises the pressure in the wheel case and increases the passive resistances of the wheel, checks the expansion of the steam in the nozzles, and together with the steam throttle valve holds the speed within the normal limits. In case of accident to the governor valve mechanism this air valve will operate, also.

The peripheral velocity of the gear wheels is about 100 feet per second. The pinion is made of high-grade high-carbon crucible or nickel steel. The gear wheels are made of soft steel of low carbon. The teeth are carefully generated at an angle with the shaft center and the pitch is very small, insuring a smooth contact with a minimum amount of noise. The noise cannot be entirely eliminated, but with great care in cutting the teeth, and giving close attention to alignment and center distances, it has been possible to reduce it to a minimum and to a point where it is in most cases of no consequence. The gears are continually lubricated, but with a very small amount of oil. If they get the proper amount of lubrication and care is taken that no sharp grit, such as cement dust, coal dust, or the like, is allowed to enter them, they will operate for many years without visible wear. The gears are encased as much as possible, to prevent the entrance of dust or foreign matter. The gear wheels were originally made of bronze, but it soon developed that this material, as a rule, became crystallized after about two years of continuous operation, when pieces of the teeth were broken off and destroyed the gears. Steel gears have now been in operation for about nine years, without showing any of the disadvantages of bronze.

Little is to be said about the bearings. They are all lined with white metal. The low-speed bearings for the gear shafts are similar to bearings for electrical machinery of same speed, and are provided with ring oilers. Ring oilers, on the other hand, have not proven satisfactory for the high speed bearings. The turbine wheel shaft usually vibrates slightly, which is communicated to the oil rings, they then refuse to follow the shaft, and consequently do not furnish proper lubrication. It is also found that the temperature of the oil in this case will increase too much, and drip lubrication has been found more satisfactory, only a small quantity of oil being required. With the high speed it is very important that the lubrication should not be interrupted, as it takes but a short time for the bearing to run hot. Wick lubrication has so far proven the most reliable. It must, however, be arranged so that the oil leaves the wick tube in drops, and with a sight glass below the tube through which the amount of feed can be ascertained. The oil is filtered by the wick, which insures clean oil in the bearing, and the oil will flow as long as any oil remains in the tank. With oil tanks of ample size there will not be much attendance required. It seems, though, in the present advanced stage, that opposition is sometimes met with in having this method of lubrication used. The common sight-feed lubricator with such a small number of drops as are required, has the disadvantage of a very small opening for the oil, so that a small amount of dirt will suddenly interrupt the lubrication. The bearing will then immediately heat. Any mechanical arrangement for forced lubrication is in itself more or less apt to get out of order.

In the De Laval turbine, like any other radically new machine, there have been practical difficulties to overcome. There have been troubles with bearings becoming overheated. This was partly due to faulty workmanship, but in many cases it can be ascribed to the lubrication, either to failure to keep the oil reservoir filled, or else to sight feed lubricators, which in themselves might cause trouble.

Then there has been trouble with buckets. It has sometimes happened that one or more buckets have broken, and come out of the turbine wheel, but without doing any further damage. Generally the turbine, after losing a bucket, can be continued in operation, as the turbine shaft is sufficiently flexible to take care of the unbalancing, though it is best to take out the turbine wheel and replace the buckets. The only explanation of this trouble is that the buckets are subjected to vibratory strains, due, perhaps, to the turbine wheel not being homogeneous, so that it will, under action of the centrifugal force, expand unevenly in different directions, thereby unbalancing and causing vibration of the wheel at full speed. This trouble has been overcome by replacing the wheel.

The buckets are also subject to more or less wear due to the action of the steam. The cause of this is also very difficult to determine. It may be that the buckets are chemically affected and that thin films of oxide are blown away by the steam, or it may be caused by mechanical wear due to small solid particles coming with the steam, such as rust, or scale from the pipes. It may also be due to some electrical phenomena. However this may be, it is a fact that wear takes place and it is very doubtful that it can be entirely prevented. It has been found in a few cases that buckets have been worn out in a year, necessitating replacement. In other cases the wear has been very slight, even after a run of four to five years. The wear affects only the steam inlet side of the buckets, and will only increase the steam consumption to a slight degree. In tests made on a turbine of 100 horse-power, where the edge of the buckets had been worn away about one-sixteenth inch, the steam consumption was about 5 per cent. higher than with new buckets. The wheel and buckets are, however, so designed that an insertion of a new set of buckets can be easily made at a small cost.

THE PARSONS STEAM TURBINE.

From a Paper by Francis Hodgkinson upon "Some Considerations in Steam Turbine Work," presented at the June, 1904, meeting of the American Society of Mechanical Engineers.

Dr. Stodola, in his excellent work, "Die Damp Turbine," quotes a test by Lewici upon the friction of a 30-horse-power De Laval turbine disk in air and vacuum. The turbine was driven by a calibrated motor, and in order to bring it up to speed, the following power was required:

	Resistance.	
	Atmosphere.	19.6" Vacuum.
Dry saturated steam 3.3 H. P. =	11 per cent.	5 per cent.
Superheat 300 deg. C.....	6.25 per cent.	2 per cent.

In view of these facts, it would seem desirable to avoid high steam velocities as much as possible, because of the resulting frictional losses. Another reason is the erosive action of the steam with high velocities. This is quite serious when the steam is initially wet, due to foaming boilers. In this case, matters are generally made worse by the moisture generally carrying with it various kinds of solid impurities.

In this connection, the author lately had some hard drawn Delta metal blades exposed to two steam jets, the one issued from a diverging nozzle with 150 pounds boiler pressure behind it, and the other from a rounded orifice with 1 pound pressure. The size of the outlet of the two nozzles is the same in each case, and the respective velocities were approximately 2,900 and 600 feet per second. The blades were kept continuously exposed to the jets for one hundred and twenty-eight hours, and the erosion was considerable. A rather curious feature is that the erosion was maximum at the center and the extreme edges of the jet.

In turbines other than of the Parsons type, the original impact element has been made use of in simple or compounded form, the pressure fall being secured by nozzles and the velocity abstracted by vanes. Thus each bucket wheel presumably rotates in an atmosphere of uniform pressure at all points. Mr. Parsons, however, early conceived the idea of so designing and locating the turbine vanes that they should perform the functions of bucket and nozzle as well, at the same time confining the steam to the periphery of the wheel in order to avoid superficial friction in large disk areas. The actual construction of this type of turbine is so well known as to require only passing comment. The steam volume progressively increases from inlet to exhaust in an annular space between stator and rotor. The entire expansion, which is approximately adiabatic, is carried out within this annular compartment which essentially corresponds to a simple steam nozzle. There is this difference, however, that whereas in a nozzle the heat energy of the entering steam is expended upon itself in producing high velocities of efflux, in the Parsons turbine the total velocity, due to expansion, is subdivided into a number of steps, in each of which it is reduced through the dynamic relation of jet and vane, so that a comparatively low velocity is maintained from inlet to exhaust; this generally varying from 150 feet per second as a minimum at the high-pressure end to about 600 feet per second as a maximum at the low-pressure end. The action of the steam in this turbine differs from other types also in this respect, that the steam expands in the ring of moving blades, so that a reactive effect is produced in addition to the impulse of the steam as it flows from the guides. The total torque produced at the shaft from the ring of moving blades is, therefore, due to impact of steam from the guides and reaction from the rotating blades. This process is repeated in each element of the turbine, and the average velocity may be maintained at a uniformly low figure throughout. It is evident that here frictional losses, due to high velocities of efflux, are largely reduced.

It has often been held that unless very high vacuum—in fact, an almost uncommercial one—be provided, the economy of the turbine will suffer. This may be so in certain types in which there are idle portions of the bucket wheels rotating in dense mediums. In the parallel-flow type, however, losses from this source are not so much in evidence, by reason of the fact that the steam is confined to the annulus, and the entire circumference is active in producing torque, thus reducing the proportion of friction to useful work.

The question is frequently asked why three diameters of barrel have been generally selected in the Westinghouse-Parsons turbine. This selection has no bearing whatsoever on the design of the machine, but is merely one of mechanical convenience. The proper expansion can be provided for just as well should there be one or several different diameters. It would be found, however, that if a speed and diameter of drum were selected that would permit convenient proportions of blades at the outlet, the blades at the inlet of the turbine would become unmechanically small: similarly, if diameters and speeds were selected to suit the inlet blades, the areas of the blades in the last stages would become unmanageably large. By varying the barrel diameters at several convenient points, corresponding variations may be made in the velocity of the steam, thus permitting blade designs of convenient proportions for both extremes.

It is an important feature of the parallel-flow turbine that the entire annulus between rotor and stator is filled with working steam. It permits the use of large axial clearances between moving and stationary blades without loss in efficiency. In actual practice, this is never less than ⅛ inch, and in large blades it is as much as 1 inch. In all forms of impulse turbine, separation of nozzle and vane results in surface friction of the jet, and particularly an entrainment of the surrounding medium, as in the fashion of a steam injector, thus increasing fluid friction by drawing the steam backward through the idle portion of the wheel.

Although small axial clearances are unnecessary in the Parsons turbine, it is desirable to employ as small radial clearances as possible in order to prevent leakage of steam from stage to stage. In order to avoid over-estimating the probable extent of this leakage, it is necessary to bear in mind a point which is usually lost sight of, and which, in a considerable measure, offsets the loss from this source. In a machine of given size, the radial clearances between the ends of blades and the walls of the turbine would presumably be constant. The greater leakage would, therefore, naturally occur at the high-pressure end of the turbine, or at the beginning of the expansion. By the time the lower stages of the turbine have been reached, the total volume of the steam has become so great, compared with the clearance area, that the latter becomes unimportant. All leakage steam returns energy to the working steam in the form of heat, as its action is similar to wire drawing in a restricted passage; hence it is superheated to a slight degree and serves to partially dry the working steam which contains considerable moisture, due to adiabatic expansion.

In any type of turbine it is necessary to provide glands at the ends of the casings to prevent the escape of steam or the influx of air into the turbine at the point of entry of the shaft. Air leakage is particularly detrimental in cases where it is desirable to maintain high vacuum. Various forms of packing glands have been used, but the later type Westinghouse-Parsons turbines are fitted with an arrangement of water-sealed glands. They require no lubrication, and it is impossible for any oil to escape from the bearings or the lubricating system into the steam spaces. There are no rubbing surfaces in these glands, and it is found that they do not wear out. The water

used for sealing them is small in quantity, but it is not necessarily lost, as it may, in a power plant, be taken from the feed-pump delivery and the overflow returned to the feed-pump suction.

On the load being still further increased, an auxiliary or "secondary" valve, commences to open and admits steam as may be required to a later stage in the turbine where the working steam areas are greater, thus increasing in proportion the total power of the turbine. The operation of this poppet valve is the same as the main admission, so that the governor automatically controls the power and speed of the turbine from no load to such overloads as are generally beyond the limits of generating apparatus built on normal ratings.

The intermittent admission of steam to the turbine is productive of some gain in economy at light loads by keeping the temperature range greater than would be possible if the steam were throttled. Another advantage to be derived from this method of admitting steam is that the admission valve and the mechanism that operates it are constantly reciprocating, and consequently get no opportunity to become stuck. The reciprocating motion necessary to operate the mechanism originates with an eccentric driven by the turbine, and is transmitted through the clutch of the governor, causing a continual disturbance; such that the governor is at all times ready to go to a new position with the least change of speed, simply because the "friction of rest" does not have to be overcome.

A turbine has an important advantage: that local temperature conditions vary but little during operation and on steady load are absolutely constant. The reversals of temperature in a reciprocating engine cylinder have no equivalent. Thus the temperature of rotor and stator is at all points approximately equal to that of the steam in the corresponding expansion stages. Generally the stator is made of cast iron and the rotor of steel, so that the differential expansion that must necessarily exist between them has the effect of increasing or decreasing the axial clearances between running blades at different loads. This, however, is unimportant with this type of turbine because of the ample axial clearances provided. The exhaust end of the turbine is bolted to the bedplate, while the steam end is provided with a sliding foot working between machined ways on the bedplate, so as to permit the turbine to expand, as it will. In types of turbines, however, where small axial clearances exist, this question of differential expansion is not such a simple matter.

It has been advanced that the blade construction employed in the Parsons turbine constitutes an element of complexity, which also is conducive to low cost of construction. The author is, perhaps, not conveying new information in stating that the blades are rolled out from special bronze or steel into long strips, then sawed into the proper length, and finally mounted around the periphery of the rotor and the stator in grooves with special separating pieces, the whole being finally calked in position. In practice, it is found that with this construction the blades are never released, except through some special cause, and the construction is of immense advantage in minimizing the delays due to accidents.

In view of the widespread discussion upon the merits of a reheater in reciprocating engine work, it may be of interest to mention the results of its application to steam turbines. The earlier Westinghouse-Parsons turbines of large size were constructed in tandem two-cylinder form, for the purpose not only of reducing the span between bearings, but also to permit the introduction of a receiver between high-pressure and low-pressure cylinders, the arrangement being intended to separate as much moisture as possible resulting from adiabatic expansion, and to superheat the remaining steam. Exhaustive tests have, however, shown the reheater to be of little, if any, value in increasing the economy of the turbine when the high-pressure steam condensed in the reheater coils was charged up against the turbine. An improvement in the separator resulted in an improvement in the operation of the reheater, but, notwithstanding this, no advantage due to the reheater could be observed, and its application does not seem warranted, on account of the decreased compactness of the machine.

In the course of regular operation of power stations, it is not an unusual occurrence that wet steam comes over from the boilers, due to foaming, overfilling, or other causes. The effects upon reciprocating engine machinery need not be commented upon here. In several instances of turbine plants, slugs of water coming over from the boilers have been known to bring the turbine almost to a standstill, but without any apparent damage resulting. As soon as the water passes over to the condenser, the turbine again regains its speed. The effect on the economy of entrained moisture in the steam has been found to increase the steam consumption to an amount about twice the percentage of moisture in the steam, i. e., 2 per cent. of moisture will decrease the economy about 4 per cent.

Finally may be mentioned the system of lubrication desirable with turbine outfits. Essentially a point in mechanical design and independent of the steam cycle, it is nevertheless one on which the successful operation of any machine is absolutely dependent. Although possessing extraordinary features of excellence in the matter of securing great compactness of design, forced lubrication—as ordinarily understood to mean oil under high pressure—does not seem entirely desirable. In the Parsons type of turbine, the projected areas of the journals are proportioned so that the entire weight of the rotating element may be supported upon a fluid film of oil through capillary action alone. A small pump, driven from a worm gear upon the shaft, circulates oil through a closed system, comprising in the order of their arrangement: pump, oil cooler, bearings, and reservoir. The oil is always applied to the bearings at the point of least pressure; that is, it enters at one end and follows a groove along the top of the shell, from which it is distributed around the shaft. The pressure impressed upon the fluid films is due simply to a static head of 1 to 3 feet, sufficient to insure thorough flushing of the bearings. It is probable that the shaft never comes into actual contact with the bearings, but is separated by the oil film. This is evident by the fact that bearings when taken out for inspection after several years' continuous run are found to be subject to practically no wear. In several cases, the original tool marks upon the interior of the shell have been preserved.

The benefits resulting from the employment of a closed oil circulating system and large bearing areas are apparent in the cost of operating a turbine in regular service. As a result of inquiries in several concerns employing Westinghouse-Parsons turbine machinery, it has been elicited that a turbine ordinarily consumes about ¼ gallon of high-grade engine oil per kilowatt capacity per year; or, in other words, the total quantity of oil used per year averages about 100 gallons for a kilowatt turbine. As this oil costs from 25 to 50 cents a gallon, the expense for oil for the turbine is not ordinarily over 7½ to 12½ cents a day, and even this is not all directly chargeable to the turbine, as it is common practice to utilize the oil which is removed from the circulating system on auxiliaries and other low-speed machinery.

It is well known that flexible bearings are employed on Parsons turbines of small sizes in order to permit the rotor to revolve about its gravity instead of its geometric axis, this being necessary at the high speeds employed in order to neutralize the effect of minute errors in the balancing of the disks. The flexible bearings consist of a nest of concentric bronze sleeves with sufficient clearance between them to permit the formation of oil films, which act as cushions, permitting a certain amount of vibration of the shaft, but at the same time restraining such vibration within narrow limits. In the larger sizes of turbines, however, and, in fact, for all machines running below 1,200 revolutions per minute, the flexible bearing is no longer found necessary, and is replaced by a solid split self-aligning journal, lined with anti-friction metal, as in the ordinary forms of low-speed machinery.

* * *

The so-called bronzing process largely used on cast-iron hardware is produced by heating the pieces in the presence of oil, according to a note on the process published in *Modern Machinery*. After the surface is thoroughly cleaned and polished a coat of vegetable oil, say, sweet or olive oil, is applied, and the piece is carefully heated up to almost the igniting point of the oil. At the moment of decomposition the cast-iron will absorb oxygen, and this forms on the surface a brown oxide skin or film, which takes a fast hold and is so hard that it will admit of a high polish, thus bestowing upon the iron a most striking resemblance to bronze.

MAKING MASTER CAMS.

R. E. FLANDERS.

The method of originating master (cylindrical) cams, which is described in the following paragraphs, has been used successfully in a shop where considerable of this work is done.

A development of the cam at the surface of the cylinder is provided by the draftsman. If the cam is smaller than 2½ or 3 inches diameter, or has unusually steep pitches in its make-up, the development had best be laid out for a diameter two or three times larger than that of the desired cam.

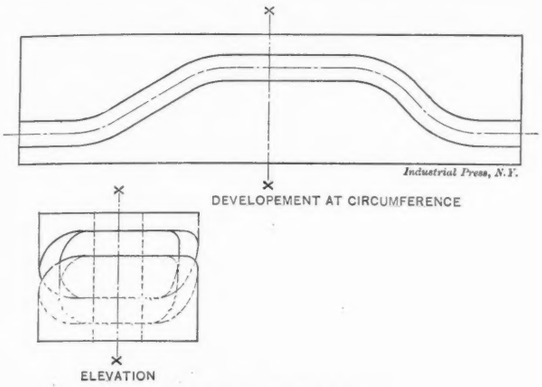


Fig. 1. The Cam and its Development.

Suppose it is desired to make a master for the cam shown in Fig. 1. The first step is to make a template to match the development shown in the drawing. This template may be made of mild steel, of a thickness depending upon the diameter to which it is to be bent, as described later. It may be fitted to the drawing with cold chisel and file, or, if considerable accuracy is desired, in the throw, the template may be held in the milling machine vise, and the straight surfaces finished to the graduations. This template, shown in Fig. 2, is made for one side of the cam groove only.

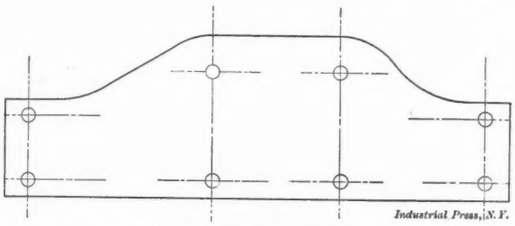


Fig 2. The Template.

The next step is to turn up a piece of steel or cast iron, as shown at *B*, Fig. 3, to such a diameter that when the template *A* is wrapped around it, as shown, the ends will just barely meet. This diameter is about the thickness of the plate less than the diameter to which the development was laid out, but it had best be left a little larger and then fitted. The plate is now clasped around the body, with the back edge pushed close up against the shoulder to insure proper alignment of the working surface of the cam. If any difficulty is experienced in this wrapping process, a circular strap may be bent up with projecting ends as shown in dotted lines at *C*; with the aid of a clamp, *D*, the template may be stretched around smoothly. The template and the body may now be drilled and tapped for screws, as shown, and for dowels as well, if found necessary.

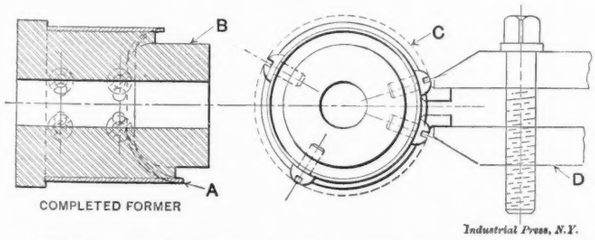


Fig. 3. The Template secured on a Mandrel to make the Former.

Scribe the contour of the cam onto the body *B*, remove the template, place the body on an arbor in the index centers of the milling machine, and take away the stock for about ⅛ inch deep or so for 1-16 back of the scribed line. This, as shown in Fig. 3, is for the purpose of providing a clearance underneath the working edge of the template. The template may now be placed in position on the body once more, and fastened there. The rig is now ready for use as a former for making a master cam.

Fig. 4 shows a milling machine arranged for cam cutting. *E* is a casting made to grip the finished face of the column, and carrying an adjustable block *F*. Cam roll *G* is pivoted on a post which is adjustable in and out in block *F*. Our former *H*, and master cam blank *I*, are mounted, as shown, on an arbor in the index centers. By working the index worm crank, and the longitudinal feed crank together, roll *G* may be made to follow the outline of former *H* in such a fashion that the end mill will cut the desired groove in cam blank *I*. A slightly smaller mill may be used for a roughing cut, but it goes without saying that the roll and the finishing mill must be of about the same size if a true copy of the template is desired. It will be found easier to follow the outline with the roll if the steeper curves are traced down rather than up.

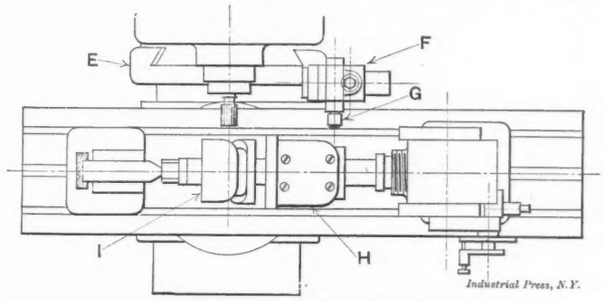


Fig. 4. Set-up of the Milling Machine when using the Former.

A fairly decent cam-cutting machine for making copies of the master cam *I* may be improvised by using the attachment *E*, *F*, *G* in a rack feed machine. It might also be feasible to connect the index worm with the telescopic feed shaft so as to give a power feed to the contrivance. To insure accurate cams, the arrangement for holding the tool must be made stiff enough to move the table without much spring, or the table must be weighted, so as to bring the pressure of the roll constantly against one face of the master cam.

* * *

JIG MAKING.

ACCURATELY SPACING THE HOLES.

FRANK E. SHAILOR.

"Interchangeable parts" is a term we frequently hear, but how many parts are "interchangeable" when jigs and tools are made in the old-fashioned way? Jigs are depended upon more than anything else to produce duplicate parts, and unless the greatest care is exercised when making them the term "non-interchangeable" would be more appropriate. The following methods for accurately spacing any work are the best that have come under the writer's notice, and he invites criticisms, for if there are methods more accurate than those herein described, the writer as well as many readers of MACHINERY would be glad to know of them. Before entering upon the description it might be well to say a few words regarding the manner in which jigs are made in different factories. In some factories the jigs are made from a "master plate," described in the May issue of MACHINERY. In other shops the jigs are made from the blueprint, while in others the jig is made directly from a model by transferring the holes, etc. Therefore, in order to produce an *accurate* jig the toolmaker is obliged to employ the method best adapted to the conditions under which he is obliged to work. It has been the writer's experience that the best method for making jigs is by means of the master plate. The next best is by working from the drawing. By so doing the errors that may be in the model (and they frequently occur) are not copied in the jig. The two methods most generally used for accurately spacing the holes are by means of the milling machine and the "button" method.

Unless the milling machine is in excellent condition, being fitted with *corrected screws and dials*, the more accurate method of the two is by means of the "buttons," which will be described later.

We will first take up the manner in which the jig is spaced on the milling machine. Assuming that the part of jig to contain the holes is machined to exact shape and size, we then proceed to find the center from which the draftsman worked when laying out the holes, and the points where the lines cross is pricked. A hole is now drilled and tapped for a smaller screw, say ⅛ inch—40. A button, Fig. 5, that is hardened, ground, and lapped outside to exact size, say .250 inch, having the ends perfectly square with sides and the hole somewhat larger than the screw is fastened to the jig by means of the ⅛-inch screw.

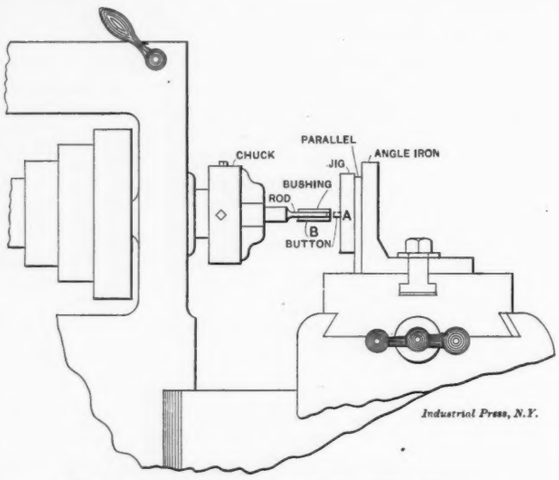


Fig. 1. Locating Holes in Jigs with the Milling Machine.

Now with a micrometer depth-gage, verniers, or height-gage, measure from *one* end and *one* side of the jig only to the button. The button is moved until its center is the same distance from the end and side of jig as the distance given on drawing, and is then securely tightened in place. When measuring to the button, one-half of its diameter must, of course, be added to the reading of the instrument used, which gives the distance to the center of button. After fastening the button, its location should be measured again for fear of its having moved when tightening the screw. Having made sure that button is in proper position the next step takes us to the milling machine.

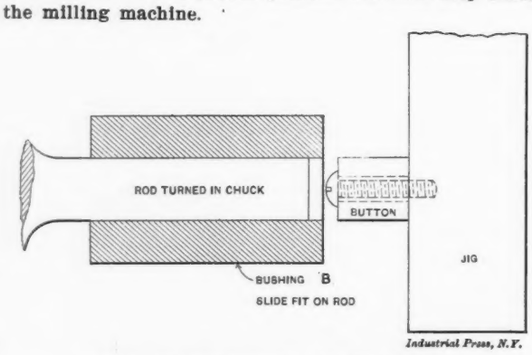


Fig. 2. The Button, Bushing and Turned Rod.

An angle-plate of suitable size is fastened to the table of the milling machine, and is squared with the machine in every way. The jig to be drilled and bored is then clamped to the angle-plate, being separated from it by parallels, and it is also carefully squared with the machine. The chuck is now placed on the spindle of the machine and a piece of brass, or soft steel rod, is gripped in the chuck and with a lathe tool held in the vise the rod is turned—not filed—to exactly .250 inch diameter, which is the same diameter as the button. A bushing, *B*, Fig. 2, about 1 inch long is next made, having a smooth hole which fits the rod nicely where turned and also fits the button. The vise is removed and the machine is so manipulated that the bushing *B* will slide *without interference* over the button. As the rod was turned in the chuck, it is therefore central with the spindle; so must also be the button on the jig.

When getting the button in alignment all back-lash must be taken up in the screws. For instance should the button on the jig be one or two thousandths of an inch higher than the rod, do not lower the knee until the bushing slips over button, but lower the knee considerably and then *raise* the knee until the bushing slips over the button. The same rule should be followed on the longitudinal movement, namely, should the button be moved a fraction past the rod, the table should be moved back far enough to remove the back-lash and then start forward again. Right here I imagine some reader saying that this is all nonsense, extra work, etc., but I think the majority of readers will agree with me that it is better to devote the two or three hours necessary to take this precaution at the beginning of a job and *know* just exactly where you are starting from and how you will come out at the finish, than to go at a job in a haphazard manner, the starting point, for instance, being a prick-punch mark jabbed into the jig at "about" the center. It saves the worry as to how the jig will test up when finished and the two or three hours (?) devoted to taking off a little here and a little there in order to overcome the errors caused by starting from a prick-punch mark.

To resume: Having made sure that the jig is centrally located on the milling machine knee, relative to the spindles, set all dials at 0 and fasten securely, for when any spacing is done on the milling machine the dials must *not be disturbed after spacing is started.* The rod and chuck are removed and a flat spotting drill, Fig. 3, is inserted in the collet and placed in the spindle. By referring to the drawing the distance given to the hole furthest from the center is noted, and the table is

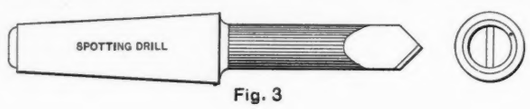


Fig. 3

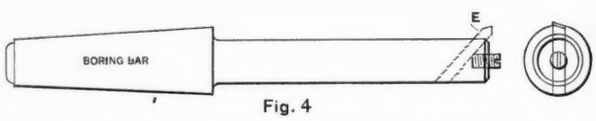


Fig. 4

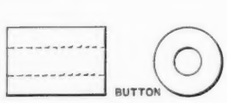


Fig. 5

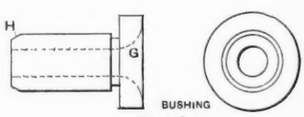


Fig. 6

Industrial Press, N.Y.

Spotting Drill, Boring Bar, etc.

moved exactly the same number of thousandths of an inch. The object in starting from the furthest hole is that the table of the milling machine is thereafter moved in the *same direction* while spotting the remaining holes. Hole No. 1 is spotted and by again referring to the drawing we move the table the given distance and hole No. 2 is spotted, and so on until all holes are spotted.

To prove that no error has been made thus far, start from the last hole spotted and work backward to the first hole, removing back-lash each time, and allowing the drill to just touch in the place spotted. If there is an error the lip of the drill will shave the side of place spotted before the center of the drill touches the bottom. Having proved each hole, the spotting drill is removed and a twist drill, which is soldered into a brass taper shank, is substituted. The holes are then drilled, care being exercised not to force the drill, which would tend to displace the jig, and also noting carefully that the drill starts in the spotted places without "springing in." After all holes are drilled, the boring bar, Fig. 4, is substituted for the drill and all holes are bored to within say 0.005 inch of the finish size, which allowance is left for the finish chip. Before taking finish chip the straps holding the jig are loosened sufficiently to relieve all strain or spring there may be in jig caused by drilling and the straps cramping same. The boring bar cutter *E* is sharpened to insure its cutting freely when

taking the finish chip, and great care must be exercised not to crowd the bar when cutter is cutting; the bar will easily "spring" and produce an untrue hole. After taking finish chip in the last hole, prove the jig again by starting backward, removing back-lash each time, as before, carefully noting that cutter does not cut in any hole.

The jig is now removed and the bushings, Fig. 6, are next in line. They are made complete on the end of a rod held in the chuck, and the hole is left sufficiently smaller to allow for lapping, and the outside is left 0.01 inch larger to allow for grinding after hardening. The end *G* of the bushing is chamfered considerably and well polished to allow drills to easily enter the hole. The bushing is then cut off from the rod. After hardening the bushings they should be roughly ground *outside* before lapping the hole. The reason is that if the holes are lapped to size the bushing will "change" a trifle when the scale is removed from outside, caused by the internal strains set up during the hardening process. Therefore, it is better to roughly grind the outside first, then lap the hole to size and lastly grind the outside to size concentric with the hole. A very true method for doing this is to turn a piece of steel held in a bench lathe chuck to fit the bushings, and without disturbing chuck or piece, wring on the bushing and then grind outside. The corners *H* should be beveled to prevent the bushing cutting the jig when being forced in. The above described method for spacing holes is applicable only to milling machines having *corrected screws and dials*.

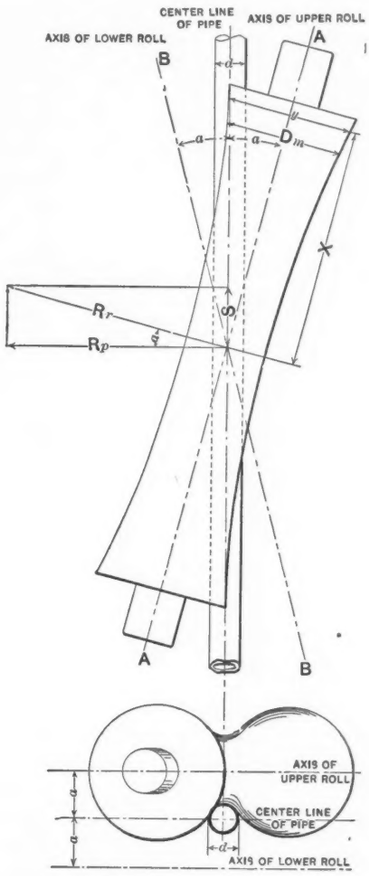
The button method already referred to consists of laying out the location of the holes on jig by means of a micrometer scratch block or height-gage, and where the lines cross a small hole is drilled and tapped. Buttons, like Fig. 5, are then fastened in the proper locations by the same manner already described, namely, measure from one end and one side of jig only to the outside of the button, adding one-half its diameter to the reading on instrument. When one button prevents measuring to next button we then measure from button to button; but it is better to measure from one end and one side of jig to button when possible to do so. Having securely fastened all buttons in their exact relative positions the jig is next fastened to the faceplate of the lathe and an indicator placed on a button. When the jig has been so located that the indicator shows the button to be exactly central with the spindle of lathe, the button is removed and hole drilled and bored. The greatest possible care must be taken when employing the button for spacing work, for there are possible chances of errors creeping in. First the personal error caused by uneven tension on the measuring instrument used, and secondly and greater, the possibility of one or more of the buttons becoming displaced by being unconsciously knocked out of place while working in the lathe.

Another method which is too frequently used for spacing holes, by shops claiming "interchangeability of parts," consists of laying out the jig with a height-gage or micrometer scratch-block and prick-punching where the lines cross. The prick-punch mark is then "wiggled up" in the lathe. But, granting that the lines can be *accurately* scribed on a jig, it does not follow that the point of prick-punch is placed directly where the *lines cross*. And after the prick-punch has been driven into the metal, who can say that the bottom of the prick-punch mark is directly under where the lines cross? This method might properly be said to belong to the "old school" and should be discouraged as far as possible by the rising generation of toolmakers, as at best it is only an attempt at accurate spacing.

* * *

ROLLS FOR STRAIGHTENING PIPE.

In the interesting and valuable paper read by Mr. Victor Beutner before the December meeting of Engineers' Society of Western Pennsylvania on the manufacture of welded pipe, the methods employed for straightening pipe were briefly alluded to. One method employed on the smaller sizes of pipe is to roll it back and forth between large reciprocating plates, very much in the way that our grandmothers straightened knitting needles, that is, by rolling them on the floor with the foot. The best method, however, is said to be that by which the pipe is passed longitudinally between two hyperboloid rolls. This device, shown diagrammatically in the cut, rotates the pipe and pushes it forward at the same time. For clearness in the illustration the lower roll is omitted, it being a duplicate of the upper roll but placed so its axis coincides with the line *B B*. Mr. Beutner makes it appear as though the curve of the rolls is a very complicated affair and he presents a formidable mathematical formula to back the statement up. The principle will be readily understood, however, from the diagram. It will be seen that the greater the angle *a*, the longer is its sine, which corresponds to the longitudinal movement of the pipe through the rolls. The rotary movement of the roll at the middle section is divided into two components, of which *S* is one and *R p* the other.



Rolls for Straightening Pipe.

It is of interest to note that substantially in this manner the velocity of an idler pulley bearing on a broad belt can be varied, that is, by changing its angle of inclination across the belt. When at right angles it runs at the same speed as the belt but when turned from this angle its speed decreases in the ratio of the sine to 1. In other words, when the idler is at an angle of 45 degrees the peripheral speed of the idler will be only 7-10 that of the belt, and so on.

* * *

In making cheap thermometers, says *The Locomotive*, it is generally customary to stamp the scales out in large numbers from sheet metal, and to blow the bulb of the instrument to such a size that the scale will be as nearly as practicable adapted to the finished thermometer. This can be done, by an experienced glass worker, with greater accuracy than might be supposed; but it is evident that no high degree of precision can be realized in this way. The scale and the rest of the thermometer being adapted to each other as nearly as is commercially practicable, the thermometer is then exposed to some known temperature, say 70 degrees, in the vicinity of the temperatures at which it is most likely to be used, and the point on the stem to which the mercury rises is then adjusted so as to be opposite the correct part of the scale. Such a thermometer will give readings that are not greatly in error at temperatures near the one at which it is standardized; but at other temperatures any two such thermometers will necessarily diverge by an amount which depends upon the judgment and skill of the workmen who blew the bulbs.

LETTERS UPON PRACTICAL SUBJECTS.

RE SHAILOR'S MULTIPLYING GAGE.

Editor MACHINERY:

I was much interested in Mr. Shailor's valuable hints on toolmaking in the May issue and, for one, wish to thank him for same. The publication of such articles makes MACHINERY worth many times the subscription price to every progressive mechanic, and I am glad to see the good work go on.

Having thrown my bouquet, I want to register a criticism of the construction of Mr. Shailor's multiplying gages. It seems to me to be a mistake in design to place the retracting spring controlling the pointer so far from its pivot. The pointer is necessarily slender and if the spring is placed quite some distance from the pivot it gives the pointer a chance to bend slightly between the spring and pivot. Of course this deflection is very slight but it will be observed that whatever amount it is, it is in a direction opposite to the movement of the pointer, so that a reading is slightly decreased. I do not want to appear over critical, but it is the observance of these nice points that marks the parting of the ways between good and bad design.

OLD MAN.

FORMULA FOR POWER OF MACHINE TOOLS—TABLE OF LOGARITHMS FOR THIRTY-SECONDS.

Editor MACHINERY:

Having recently had some computations to make regarding the power required for different cuts at different speeds and feeds on machine tools, I found it quite cumbersome on a series of computations, as the formulas are generally given based on the metal removed per hour.

From tests made at the Trigg Works, Richmond, Va., and published in your September, 1902, data sheets, you gave for hard cast iron on a series of experiments H. P. = .034 W, in which W is the weight of metal removed per hour.

As our data comes in the size of feed, cut and the speed in feet per minute, we reduced the above formula to H. P. = 7 F C S for an average, in which F = the feed in inches per minute, C = cut in inches, and S = speed in feet per minute.

The feeds and cuts were all in thirty-seconds or sixteenths of an inch, and using logarithms, this required first the looking up of the decimal equivalent, and after finding same, the log. To simplify the calculations we prepared the accompanying table, which gives directly the log. for each thirty-second of an inch. As this table is not found in any hand books, to my knowledge, I think a publication of same would be very beneficial to your readers.

COMMON LOGARITHMS FOR FRACTIONS OF INCH.

1/32	$\bar{2}$.49485	8/32	$\bar{1}$.57403	23/32	$\bar{1}$.85658
1/16	$\bar{2}$.79588	13/32	$\bar{1}$.60879	8/4	1.87506
3/32	$\bar{2}$.97197	7/16	$\bar{1}$.64098	25/32	$\bar{1}$.89279
1/8	1.09691	15/32	$\bar{1}$.67094	13/16	$\bar{1}$.90982
5/32	$\bar{1}$.19382	1/2	1.69897	27/32	$\bar{1}$.92621
3/16	1.27300	17/32	$\bar{1}$.72530	7/8	$\bar{1}$.94201
7/32	$\bar{1}$.33965	9/16	$\bar{1}$.75012	29/32	$\bar{1}$.95725
1/4	$\bar{1}$.39794	19/32	$\bar{1}$.77360	15/16	1.97197
9/32	$\bar{1}$.44909	5/8	$\bar{1}$.79588	31/32	1.98621
5/16	$\bar{1}$.49485	21/32	$\bar{1}$.81707	1	.00000
11/32	$\bar{1}$.53624	11/16	$\bar{1}$.83727		

W. F. BRECHT,
Philadelphia, Pa. With Morse, Williams & Co.

CHUCK FOR END MILLS.

Editor MACHINERY:

The halftone, Fig. 1, shows an end-mill holder and two of the mills as well as the cone-nut. A square-end key, not shown, fits a socket in the cone-nut, and is worked through the hole in the hollow spindle. The line cut, Fig. 2, represents a sectional view of the arrangement assembled. In the issue of July, 1902, I described a device similar to this, but considerably smaller; this is in use to-day and works so satisfactorily that we adopted practically the same idea for larger mills, the straight one in Fig. 1 being ¾ inch diameter.

The trouble with these end mills, when using the taper shank form, is that they work out. Whether this is due to the fact that we feed them heavily side-on into cast iron and that part of the time they have no metal in front of the end to prevent their working out, I do not know. Whatever it

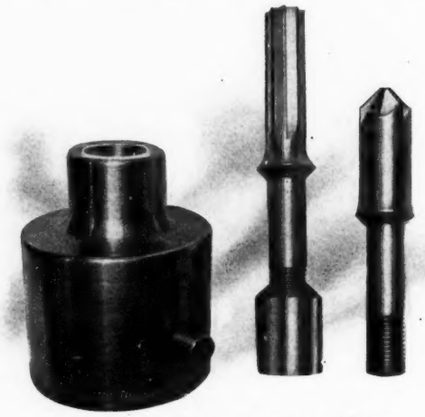


Fig. 1. End Mill Holder, Cone Nut and Mills.

be, we could not make the taper shank mills do the work, and the device herewith illustrated does the job quicker, better and spoils no work by coming loose.

All the parts are tool steel and hardened at the conical surfaces. The nut loosely fits the taper hole in the spindle, and

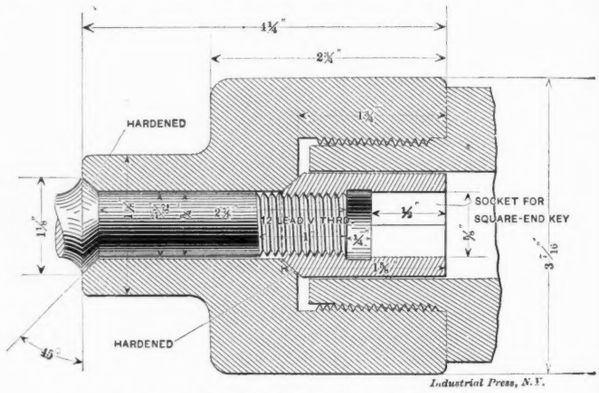


Fig. 2. Longitudinal Section of End-mill Holder.

when screwed home on the shank of the end mill with the key through the hollow spindle, holds the mill securely and true by the conical surfaces of the nut, the end mill and the holder.

CORNEIL RIDDERHOF.

Grand Rapids, Mich.

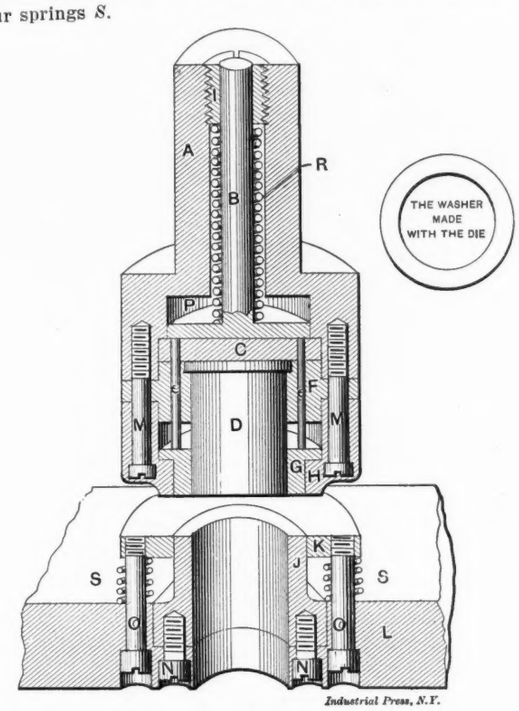
COMPOUND PUNCH AND DIE FOR LEATHER WASHERS.

Editor MACHINERY:

I send you a sketch of a compound punch and die, for blanking leather washers, for the filler valve on a gasoline stove tank. I am not sending you this because it is anything new, but more for the design, as I have never seen a compound die constructed exactly like it before.

The cut shows the punch and die one-half size. A, B, C, F, G, I and K are of machinery steel, while D, H and J are of tool steel, and L of cast iron. A, which represents the shank of the punch, is bored out large enough to accommodate the spring shown and is held in position by the tension plug I, which is bored out so that the shank of the knock-out B passes through it and keeps it in alignment with the portion which travels in P. It will be noticed by the drawing that the lower portion of A is bored a little larger than P where C fits; C acts as a backing for the punch D. The piece C is made a nice fit into A, while F acts as the punch holder and is made a nice driving fit into A and H, and the punch D is made a nice fit into F. G, which is called the knock-out or kicker,

is operated by four pins *e*, *e*, etc., which pass through holes drilled in *F* and *C*, and work against *B*. As the punch ascends the spring *R* forces the blank or washer from the punch, and leaves it on the upper face of the die, while *K* strips the stock from the die, and as soon as the punch and die are separated the blank is ready to slide off, if worked in an inclined press; otherwise it must be picked off by hand. *H*, which is the outside cutting die, is held by four ¼-inch fillister screws *M*, and as *H*, *F* and *A* are all snug fits, there is no danger of its shifting. The lower half of the die is made as follows: *L*, which is of cast iron, is made to fit a 4-inch shoe, and is bored out to receive the piece *J*, which is held in place by the four fillister screws *N*; *J* is a snug fit in *L*. The stripper *K* is held in place by the four fillister screws *O*, and operated by four springs *S*.



Compound Punch and Die for Leather Washers.

It does not seem necessary to give any more instructions in regard to the punch and die, as I believe the drawing shows the construction more plainly than I can describe it, but I might say that I gave no clearance at all, as it was necessary to keep the washers the same size. I thought if I gave it no clearance, there would be no danger of changing the size when grinding, and as the punch does not enter the die over 1-16 inch, it has given excellent satisfaction. I have made several compound dies since, with no clearance, and find they give good results when blanking thin stock, as it does away with the burr, and there is no chance for it to change in size when grinding. While this may be old to some, and no doubt it is, I hope it will be of some help to the younger mechanics who are trying to work their way to the front.

Lorain, Ohio. W. VAN ORMAND.

CHUCK AND MILLING FIXTURE FOR GAS ENGINE FLYWHEELS.

Editor MACHINERY:

I send herewith sketches and description of two fixtures used for machining gas engine flywheels. The fixture shown in Fig. 1 is for holding the wheels for turning, and admits of the rim being finished all over at one setting. The three pivoted jaws of the chuck enter the three cored holes in web of the wheel and when the setscrews are tightened, they hold the wheel with a bull-dog grip, the rim projecting beyond the chuck so that both sides are accessible for turning. The inner end of the hub is faced with an offset boring tool.

Fig. 2 shows a fixture used for milling the angular slot in the rim of the flywheel for the starting handle. Fig. 3 shows the handle inserted in the wheel for use, and Fig. 4 the position of wheel and end mill at the completion of the milling operation.

The wheels are first centered as shown, and a hole the same size as the end mill drilled in the side of the rim on a line

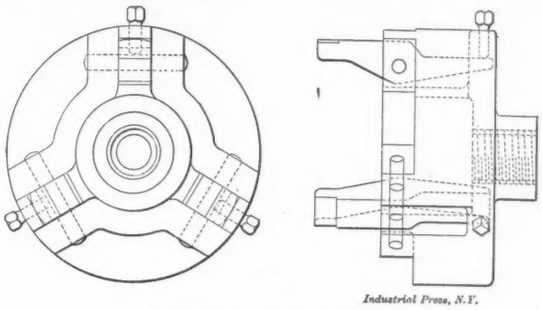
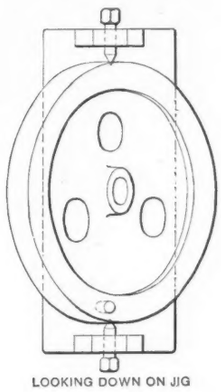


Fig. 1. Chuck with Pivoted Jaws.

passing through the centers and at right angles with the surface. The wheels are then mounted on the centers of the fixture and the end mill inserted in the hole until the collar thereon bears against the surface of the wheel. The spindle



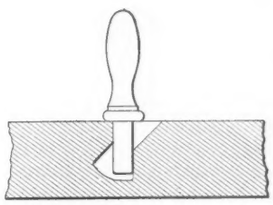
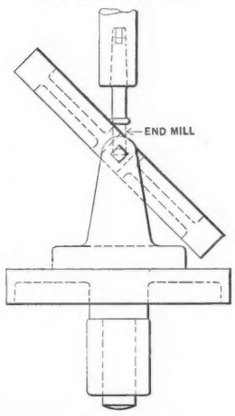


Fig. 3



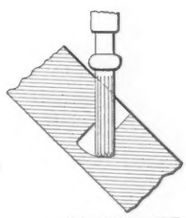


Fig. 2. **Fig. 4.**

having been started, the wheel is slowly tilted to the position shown in Fig. 4. As the wheel is tilted, the spindle carrying the end mill must be raised, the collar on the mill being kept in contact with the surface of the wheel. C. R. S.

"WHERE INTERCHANGEABILITY PAYS."

Editor MACHINERY:

Your editorial on the above subject in April MACHINERY where you refer to the Russian defenders at Vladivostock being at the mercy of the Japs on account of the shot being a trifle too large for the guns, brings up the point that we would be in the same condition had the champions of the metric system succeeded in forcing its adoption on this government. A hundred-millimeter gun varies just enough from a 4-inch one so no man could tell the difference between the sizes of shot without calipers, and I venture to guess that the trouble with the Russians was not because the guns were not made standard, but because some one has been trying to introduce the metric system, as they have been doing in this country for

the last sixty years and where they have succeeded to that extent that our army is blessed with a 75-millimeter gun while all others are in inches. Fortunately perhaps they may not have a 3-inch to make a misfit.

In your reference to the variation in hose couplings, it is not the nozzles that do not fit, but the hose couplings do not fit the hydrants, though that is now being remedied by the adoption of a suggestion made by Mr. W. H. Harris of this city. The cities and villages throughout Central New York are supplying their departments with reducers that fit the hydrants at one end and the neighboring cities' hose at the other. In connection with this there is a little history.

Some ten years ago just after a fire where this trouble gave our fire department a painful experience, the idea of this reducer was given to the president of our Fire Board, who was one of the most enthusiastic fire-fighters, and he failed to see enough in it to do anything toward its adoption. Three or four months ago, following the Rochester fire, the suggestion was made public through one of our daily papers and then in the *Firemen's Journal*, and the scheme is being put in practice, as above indicated, which shows what publicity will do.

Syracuse, N. Y. JOHN E. SWEET.

COOPER HEWITT LAMP FOR BLUEPRINTING.

Editor MACHINERY:

The photographs shown in the March, 1904, MACHINERY exposed by the light of the Cooper Hewitt lamp, have already brought to hand enough letters of inquiry regarding the use of the light for photographic and printing purposes to indicate that many are interested in its use. These letters have

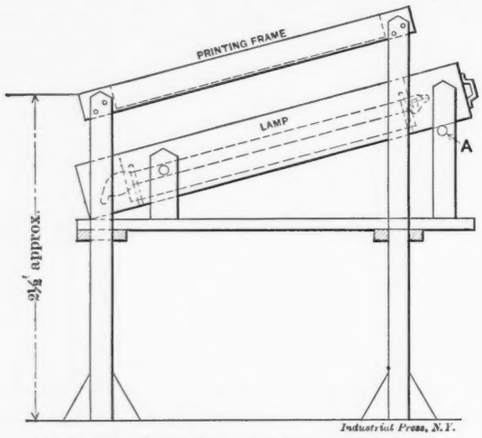


Fig. 1. Blueprinting Frame for Cooper Hewitt Lamp.

been of interest to me, and it may be that your readers will be interested in a further notice of the uses of the lamp. The manufacturers of the lamp have as yet put no blueprinting machine upon the market, but the lamp is used in blueprinting as in photographic printing by arranging the printing frame in front of and close to the lamp tube.

A single lamp, when the lamp and frame are stationary, will print a strip about nine inches wide, the whole length of the lamp. If wider prints are to be made either more than one lamp must be provided or the frame and lamp must have a relative motion. Fig. 1 shows a simple method of arranging the blueprinting frame and lamps where they are stationary. For 36 inch x 48 inch prints made in this manner the makers of the lamp advise the use of four of their tilting lamps with nickeloid reflectors. The lamp tubes are arranged to lie about 10 inches from the printing frame glass and prints can be made in one and one-half to two minutes.

If only one lamp was to be used it could easily be provided with a mechanical carrier to traverse it across the space occupied by the printing frame at the proper speed to give good prints. As the greater amount of photographic printing is done in 8 x 10 inch sizes and smaller, to use the full length of the lamp it becomes necessary to provide a frame with suitable openings to hold several of the small printing frames.

Fig. 2 shows such a frame and two lamps arranged as spoken of. In using the lamp to photograph objects with, it is obvious that the shorter the exposure is to be made, the more in number must be the lamps. Where several lamps are used, Fig. 3 shows a common arrangement. In this device each lamp has its individual reflector and each lamp can be run separate from the others in the group. The whole grid or frame can be swung to a position that will light the object being photographed in the best manner possible. By turning on one or several of the lamps, the intensity of the light can

Fig. 2

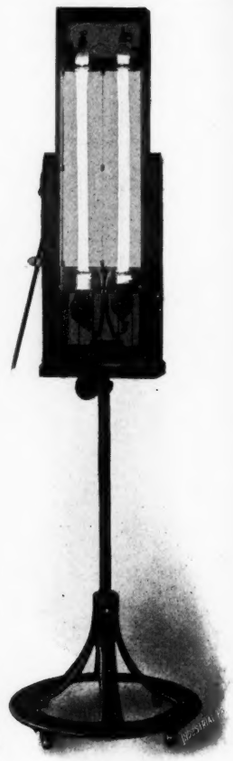


Fig. 4

be varied at will. Where large machines are being photographed, lamps swung on movable stands are used, in just the same way as white reflectors have always been used to light the darker or more obscure parts. Of course, the light must not be so placed as to shine directly into the lens if good results are expected.

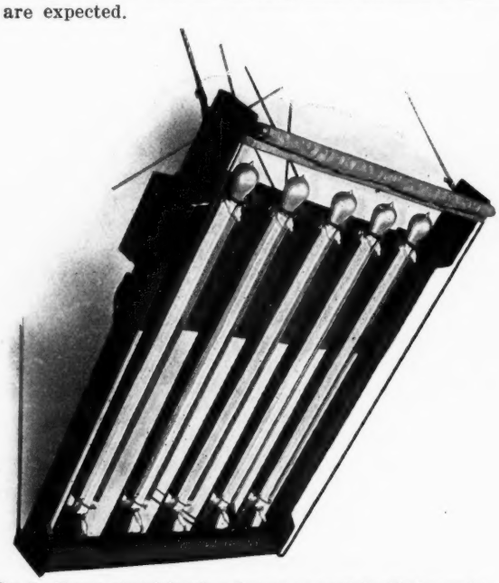


Fig. 3. Frame containing four Lamps as used for Photography.

Fig. 4 shows the lamp as it can be mounted upon a stand when it is desired to use it to light various parts of the machine not lighted by the overhead light. In photographing machines, as in portrait work, a combination of side and overhead light is desirable. H. P. FAIRFIELD.

Worcester, Mass.

[To supplement Mr. Fairfield's letter the Cooper Hewitt

Electric Company have sent us a photograph of the arrangement, shown in Fig. 5, built for the H. H. Franklin Manufacturing Company, Syracuse, N. Y., which uses four V-5 lamps. These lamps have an average life of 1,600 hours and are designed for 100 to 150 volts; two lamps in series may be run on 200 to 300 volts. The Franklin outfit consists, in addition to the lamps, of an ordinary blueprinting frame secured in a stationary position at an angle of about 45 degrees, with the glass side downwards, of course. The lamps are mounted on an independent frame provided with rollers running on short lengths of track. The lamps are tilted for lighting, and then the lamp frame is run underneath the loaded blueprinting frame. It is said that the Franklin Company are much pleased with the outfit; they secure prints in one and one-half to two minutes' exposure.

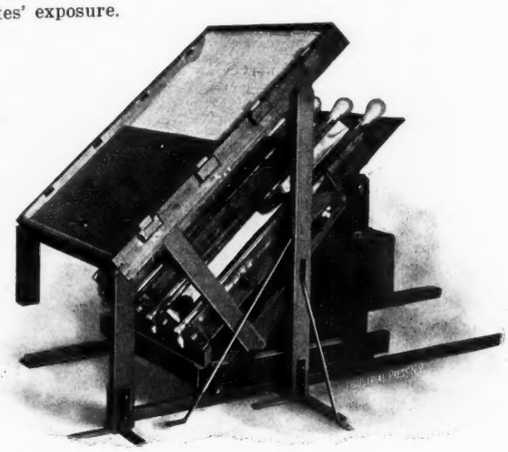


Fig. 5. Blueprinting Frame used by H. H. Franklin Mfg. Co.

While the Cooper Hewitt Company believe that the above is about the best arrangement for blueprinting purposes, using the ordinary frame, they suggest that a possible improvement would be the placing of the blueprinting frame in an almost horizontal position, the inclination being, say, 5 or 10 degrees from the horizontal. The frame could then be more conveniently loaded. The lamps beneath the frame would be lighted by removing the pin *A*, Fig. 1, and lowering the box-holder to allow the mercury to run into the normal upper end of the lamps; raising the holder into position would light the lamps. —EDITOR.]

"THE ETERNAL QUESTION."

Theodore Disch.

Editor MACHINERY:

The article in the April number under the above heading was read with interest by me, and brought back to my mind some of the many experiences in the past thirty-eight years of my shop life. Serving apprenticeship has changed wonderfully in that time, and sometimes I think not for the better for either apprentice or employer.

In those early days the employer took an interest in his employees other than what he could make out of them in the way of money. If he had an apprentice who showed that he wanted to learn and was willing to do his share, his boss took a pride in him and gave him every opportunity to expand, and if in the end he turned out to be a good mechanic his employer was proud of it, and said so. Nowadays his employer hardly knows him, neither does he care as long as the business pays. It is only in the smaller shops that the employer comes in close contact with the apprentice, and then not as close as he used to or ought to, because formerly the employer made it his business to know the boys' families, their circumstances, etc. That is all past now except in rare cases. Formerly schooling was hard to get, and more had to be learned in the shop than now, and he was generally a better mechanic than he is nowadays. He had a better chance to get around the shop to see how things were done and what was being done. Now a boy must stay where he is put. He goes into a shop to serve his time. In the shop they have a routine: First six months on a bolt cutter or cutting-off machine, then on a drill press, then facing nuts or turning bolts, then a shaper or milling machine or some special machine. But the main point is to put him where he can *earn* the most money for the concern. The learning of the trade is a secondary matter with the shop; it must all be in the boy. If he leaves his machine or his work for a few minutes to take note of how this or that is done the foreman calls him down, or if he don't he will get called down himself for not keeping the boy at work.

Mr. Ridderhof says Frank had been working at the trade for eighteen months and did not know how many thirty-seconds there were in an inch. That goes to prove what I say. The people he worked for eighteen months did not care whether he knew anything or not; they kept him at work as long as he was satisfied to earn money for them, and when he got tired of his job he quit or kicked and got fired, as the case may be. I know a great deal depends on the boy, but a whole lot lies in the system.

Formerly men in the machine business were machinists themselves; they were practical machinists. They did not make a fortune at the business in a few years; they felt proud of their trade, but now it is a matter of money—"How much have we made this year? How much can we make next year?" The apprentice must look out for himself. The boss don't care for him. Yes, in some cases, where the boy's parents are acquainted with some of the men in charge of a shop the boy gets a chance or is taken notice of.

I know a case now about two years old. The boy was sixteen and he refused to go to school any longer—thought he knew more than the teachers, and his folks could not induce him to go to school. The father asked me what I thought of him learning the machinist trade. I told him frankly: Let him finish his education, at least in the public school, and he will find it a great advantage in his trade. He will earn from 25 to 50 cents more a day and he will be a better mechanic, etc. Well, I could see that my advice did not take, and the first thing I knew the boy was learning the trade in the biggest shop in the city. In a few days I happened to meet him. He had bought a ten-cent rule which he showed to me. I began asking him questions, and then I found out he did not know how many inches there were in a foot—in fact he knew nothing about the divisions of the rule whatever. Still he was taken on to serve his time, and I questioned him from time to time and I found he never had a clear idea of the name of the tools he worked on or the work he was doing. He was pushed, however. First he ran a drill press, then he faced nuts, then he got a lathe. I tried to find out what he was doing, but he gave me only a vague idea. One time he stayed away from work for several days and I asked him the reason. Well, they gave him some screws to make and they kept jumping out of the lathe and getting bent, so he thought he would lay off until some one else did them and then go back.

This boy was paid more in his first year than most boys get in their third, but he will never be a mechanic. He will be one of the same kind Mr. Ridderhof writes about. But is he entirely to blame? I say no. The firms that take on such help, that pushes them along for what there is in it, that has no better system, that does not care to turn out mechanics, that only wants men to run machines, they are the ones to blame. They don't want men to think; they want to hire some one to do the thinking and some one else to do the work that is thought out.

A man hires out for a machinist helper. He is found capable. Before long he gets a machine to run. He never worked, for nothing or nearly nothing, for several years. He will get 15 cents an hour as helper. He will get 20 or 30 cents to run a machine. He is a machinist just as much as the boy that served four years. He gets as much pay. He does not know how to grind a tool. He does not have to—some one grinds them for him and sets them. In fact, he does not have to know much, only turn out the work and he is all right. He sticks to his job because he knows he cannot get

another one very quick. But the fellow that served his time is no better off. He is a lathe hand, big or little, or a big planer hand, or a small planer hand, or a boring mill hand, or any other one thing. But is he a machinist?

Formerly a machinist was a man who could chip and file, run a drill press, lathe or planer. He could work at the vise or on the floor; in fact, he could do anything required of him in the machine shop. He could dress and temper his own chisels, drills and lathe or planer tools. He knew something about pattern work. He knew about blacksmith work, and knew how a casting was made. How many young men that

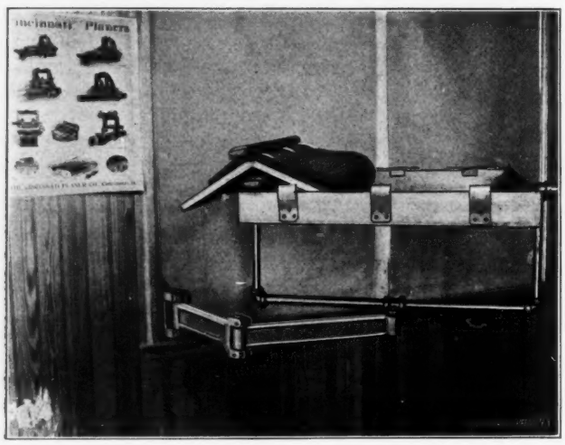


Fig. 1. Blueprinting Frame swung out from Wall.

learn the trade learn these things. I think only a small portion. Some I know don't care and others did not have the opportunity.

As Mr. Ridderhof says, it is hard to suggest a remedy, but I think a civil service examination would do a lot of good in the hiring of suitable applicants, and then a desire on the part of the employer to help the boys to become something besides a machine would go a long way toward turning out better mechanics. I believe it would be better for all parties concerned if employers would adopt some system of employing and teaching apprentices. I have had the pleasure in

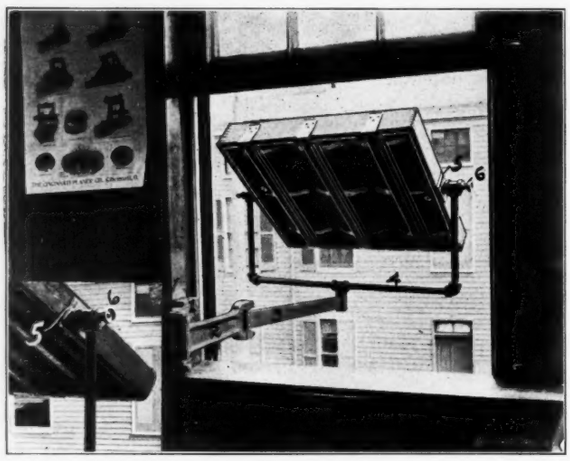


Fig. 2. Blueprinting Frame swung out of Window; also detail of Hinge.

several instances of receiving thanks from apprentices that served under me, after having been journeymen for several years, for what I did for them while serving their time.

Milwaukee, Wis. THEODORE DISCH.

BLUEPRINTING FRAME.

Editor MACHINERY:

The accompanying halftones, Figs. 1, 2, and 3, illustrate a blueprinting frame, in use at the Cincinnati Planer Co., which is a big improvement over the old style runway that is usually built out of the window on to the roof, or extended out on brackets, and taking up a great deal of space inside of the room when not in use. The frame in the photograph can hardly be called entirely new, as it is merely a combination and improvement over the many similar frames in use in the Cincinnati shops.

Fig. 1 is a view showing this frame swung out from the inner wall with the glass down ready to receive the tracing and blueprint paper. Fig. 2 shows the frame swung out of the window, and shows how easy it can be put in any desired position to suit the light. Fig. 3 shows the frame pushed up against the wall, and illustrates just how little space it occupies when not in use. Fig. 2 shows clearly the various parts required to make this frame, of which 1 is a bracket which is fastened up against the side of the window frame, 2 the first link which extends out from this bracket, 3 the second link, which is put in only to get the universal motion and a longer reach. The part 4 is made entirely of pipe to make it

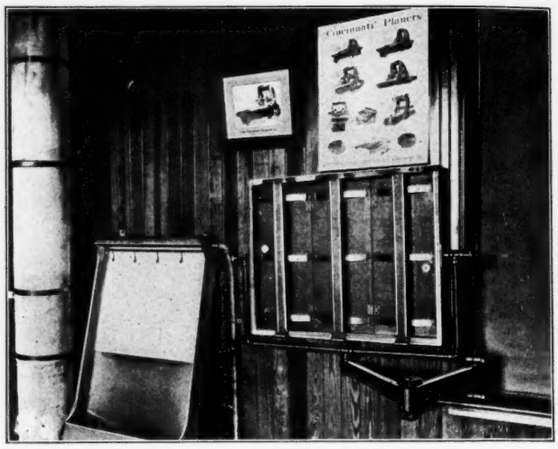
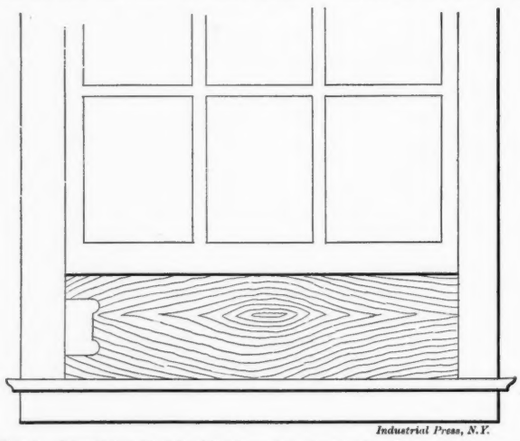


Fig. 3. Frame folded and swung against Wall; also Vertical Washing Tray.

as light as possible, 5 are brass castings, one of which is fastened to each end of the blueprinting frame and 6 are little knurled knobs, which are used to tighten the frame in any position after same is set.

Fig. 3 also shows a wash trough for blueprints, the same as that which was illustrated in the March issue. This is the identical wash trough, in which the so-called "stick-to-itiveness" was developed, but later found faulty when only one blueprint was desired, and for this reason a small rod was put through the top of the frame with several pieces of wire extended down, which can be faintly seen in the photograph. On the outer end of the rod there is a weight attached made out of an old casting, so that when a blueprint is put in posi-



Industrial Press, N.Y.

Fig. 4. Board for closing Window Aperture when Frame is in use.

tion, it is only necessary to raise this weight slightly, put the paper under the wires, and the pressure of the wires will hold same against the stream of water.

In the extreme left of Fig. 3 can be seen a large pipe, which is our exhaust pipe; this passes through the drawing room on its way to the roof. By putting a few rubber bands around the asbestos covering to hold the tracings, it forms a rapid drying apparatus after the prints are washed.

In cold weather a board, as shown in Fig. 4, is put under the window to keep out the cold.

Hartwell, O. WM. ZINSMEISTER, JR.

DECIMAL THREADS AGAIN.

Editor MACHINERY:

The article on "Decimal Threads," by Mr. Fred H. Colvin, in the April number of MACHINERY, was read with interest. His method is, however, open to criticism, as he does not get exact results, when he could do so just as well as not. If you will allow me the space I would like to show you how I get at these fractional and decimal thread examples, and for the benefit of those who may be a little rusty on fractions and ratio, perhaps it would be well to state a few facts or rules concerning these subjects, which we used to study in school:

Multiplying or dividing both terms of a fraction by the same number does not change the value of a fraction. The relation of one number to another of the same kind is, ratio.

When the relation of one number to another is sought, the first number is the dividend, and the second the divisor.

When the relation between two numbers is sought, either may be considered as dividend or divisor.

The numbers compared are called the terms of the ratio.

The sign of ratio is the same as that of division without the dividing line, and it means the same.

Now we know that division may be indicated by placing the dividend over the divisor in the form of a fraction, and ratio can be indicated in the same way, by placing the first term over the second in the fractional form. Thus, the ratio of 12 to 8 can be indicated 12:8 or 12-8, and according to the first rule 12-8 = 3-2 (dividing both terms by the same number, 4), and we know that when we multiply one fraction by another we multiply the numerators together for new numerators and the denominators for new denominators, hence the fraction 12-8 might be considered as the product of 3-4 × 4-2, or 4-4 × 3-2, etc., or it might be expressed in the form of $\frac{4 \times 3}{2 \times 4}$. This juggling should be remembered when compounding gears.

Mr. Colvin explained very satisfactorily in his November article how to find the lead of the screw of the lathe, or its equivalent lead, so I will not go over that ground again.

It always seems to me that the best way to show any one how to do anything of this kind is to give examples and work them out, and explain as we go along. In the examples given the lathe will be considered as though when gears of the same size are placed on the stud and screw, that the thread cut will be the same pitch as the lead screw of the lathe. In the case of a decimal thread the ratio of the lead to be cut to the lead of the lead screw is the same as the ratio of the driving gear or gears to the driven gear or gears.

Let us consider Mr. Colvin's first example. A thread to be cut with a lead of .40 and a lead screw with a lead of .20. As there are the same number of decimal places in each number we will drop the decimal point and consider the numbers as whole numbers and expressing them in the form of a ratio, we have 40:20 or 40-20, which means the same thing. Now as we said before, this ratio of the leads of the screws is the same as the ratio of the gears, and if we had a gear of 40 teeth and one of 20 teeth we could put the 40 on the stud and the 20 on the screw and go on and cut our thread.

If we do not happen to have one of these gears the best thing to do is to reduce the fraction 40-20 to its lowest terms, which is done by dividing both numerator and denominator by the same number, 20. Then, we have 2-1, and now all we have to do is to multiply the 2 and the 1 by some number so as to get gears that we have at hand.

Now we will take the example where Mr. Colvin had a lead of .15 inch to cut, and the lathe had a lead screw of 6 threads per inch, or 1-6 inch pitch. Mr. Colvin stated that it would be impossible to cut this lead exactly on an ordinary lathe, but it is possible, and it is just as easy as it is to cut any other lead. Instead of stating the ratio .150 : 166 + which is not exact, it should be stated 15-100 : 1-6. Now, as before stated, the sign of ratio means the same as the sign of division and dividing 15-100 by 1-6 we get 90-100, which is the exact ratio of the leads of the screws or of the gears, and if we had gears of 90 and 100 teeth we could put the 90 on the stud and the 100 on the screw and cut our .15 lead exactly. If we have not these gears reduce the fraction 90-100 to its lowest terms in the same manner as before, and we get 9-10, and multiplying both terms of the fraction by 4 we get 36-40, These are very common gears; or we might multiply by 6 and get 54-60, which are usually found at hand. So you see there is no use of getting scared at a 6-threads-per-inch lead screw.

I once ran a lathe with a lead screw of seven threads per inch. Now 1-7 expressed as a decimal is .142857+, which looks rather unpromising, does it not? But if we proceed as before and was to have that same .15 lead to cut it would be just as easy. Thus, 15-100 : 1-7, or 15-100 ÷ 1-7 = 105-100 =21-20, which is the ratio of the gears, and multiplying both terms by 2 we get 42-40, which are very common gears. Now if the lead to be cut should be given in thousandths, we would go at it in just the same way. For instance, if the lead should be .125 call is 125-1000 and proceed as before, and in so doing you get exact results.

Now let us consider the last example in Mr. Colvin's article. It seems to me that he goes to unnecessary trouble. Example—Lead screw 6 to the inch; thread to be cut ⅜ inch lead. Solving as before ⅜ : 1-6 or ⅜ ÷ 1-6 = 18-8 = 9-4, and multiplying the 9 and 4 by 6 we get 54-24, or multiplying by 8 we get 72-32, or we might use several other combinations. There is no necessity of reducing the fractions 1-6 and ⅜ to the same common denominator, as it is a waste of time.

Now let us briefly take up the subject of compounding gears. Referring to the fore part of the article where we spoke of juggling fractions. In the same manner as we factored the 12-8, that is, divided it up into the two fractions ¾ × 4-2, etc., we will factor the 90-100 in Mr. Colvin's example where he had a lead of .15 to cut and the lathe had a lead screw of 6 threads per inch. Thus, $\frac{90}{100} = \frac{10 \times 9}{5 \times 20}$, or $\frac{10}{5} \times \frac{9}{20}$ and multiplying the 10 and the 5 by 6 we have 60-30 and multiplying the 9 and the 20 by 4 we get 36-80. Now the 60 and the 36 are the driving gears and the 30 and 80 are the driven gears, and Mr. Colvin stated in his November article how these gears should be placed on the lathe. Of course we might have multiplied the two fractions 9-20 and 10-5 by any numbers so as to get gears that we have at hand.

Syracuse, N. Y. GEO. G. PORTER.

Editor MACHINERY:

I have read with interest Mr. Colvin's article about gearing the lathe for cutting decimal threads in the April number, and would suggest a way of transforming the decimal to a fraction as a matter of convenience and accuracy when a 6-pitch lead screw is to be dealt with, as the decimal in such cases is really dangerous, as the following comparison shows:

The .15-inch lead thread is a 6 2-3 pitch, found by dividing 1.00 inch by the decimal .15, or 1.00 ÷ .15 = 6 2-3. As our lead screw is 6, we have 6 and 6 2-3 for proportional numbers. By multiplying both these numbers by 9 we get 6 × 9 = 54, and 6 2-3, × 9 = 60. We have 54 for the stud gear and 60 for the lead screw gear, which are numbers that are likely to be found with a lathe having a 6-pitch lead screw; if not, multiply by some other number that will produce numbers matching the gears in stock.

To prove: The pitch of the lead screw 6× 60 = 360 ÷ 54 = 6 2-3 the desired pitch. Now taking the approximate gears found by the decimal system we have the lead screw 6 × 44 = 264 ÷ 40 = 6 3-5, which is an error in one inch of 6 2-3 — 6 3-5 = 1-15 of one thread.

In the last example the ratio number of 2.23 must be a mistake, as it figures out to 2.25+. However in this case by dropping the balance of the decimal this figures out the same as the rule given above. But how are we to know just how much to drop or add, and isn't this decimal rule likely to get us into trouble? M. H. BALL.

BORING MILL ATTACHMENT—PATTERNMAKERS' TOOL FOR BORING SPHERICAL SEATS, ETC.

Editor MACHINERY:

In the February number of MACHINERY I find described a boring mill attachment for boring spherical seats which recalls a device that I saw used for turning large convex surfaces.

These were in the neighborhood of five feet in diameter, and the radius of the surface was about equal to their diameters.

A template, marked *H* in Fig. 1, was securely fastened in the toolpost of one of the heads, and this bar was locked in position. Upon the other bar was fitted a clamp *J* carrying a stud with roller designed to bear against the curved edge of the template *H*. The work having been clamped in position so that the center coincided with the center line on the template the free bar carrying the cutting tool was fed down and the cut started

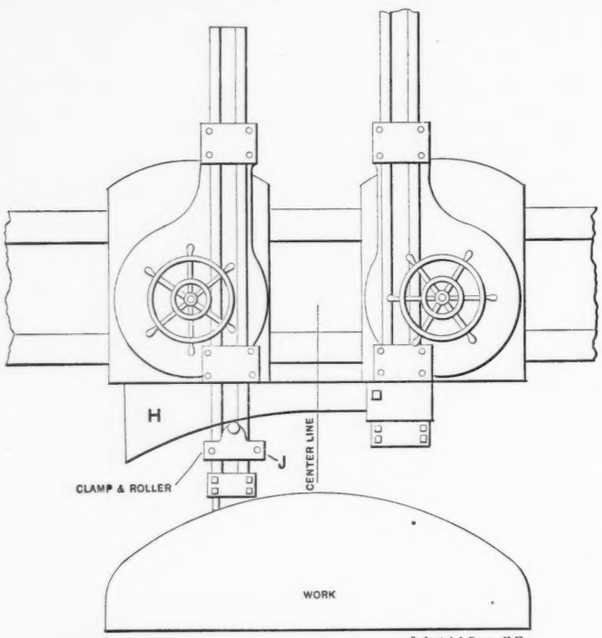


Fig. 1. Boring Mill Attachment for Turning Convex Surfaces

at the center of the work. The clamp *J* was then moved until the roller bore against the template then secured by its bolts, and the crossfeed put on. The cut shows the tool at about the middle of its travel. This device was used under the direction of Mr. Geo. Klages, Superintendent of the Specialty Manufacturing Co., of Allegheny, Pa.

Some years ago I was in charge of a pattern shop whose specialty was fittings. Occasionally we made patterns for globe valves of from four to eight inches diameter, and to turn

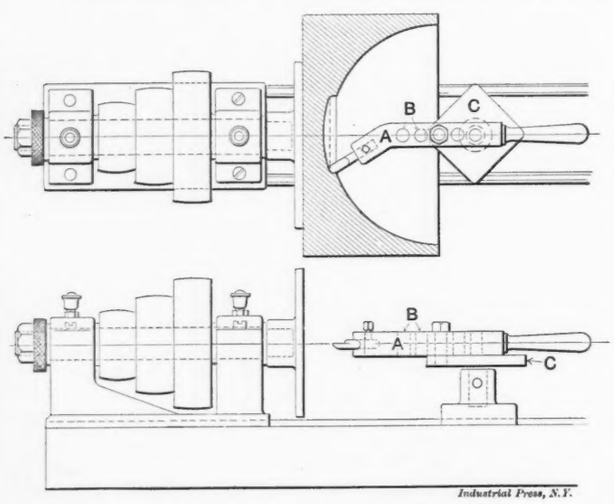
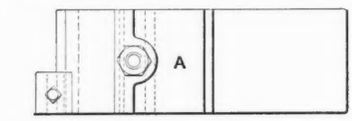


Fig. 2. Patternmakers' Tool for Boring Spherical Seats.

the spherical part of the core box I devised a special tool holder, which is shown in Fig. 2. The holder proper, *A*, is made from 1¼-inch square iron. In one end is a ½-inch reamed hole in which the cutting tools made from drill rod ground to shape and hardened are held, being secured in place by a ⅝-inch setscrew, and back of this are drilled a number of holes *B* to provide for the different sizes to be turned. *C* is a cast iron plate similar in shape to a plasterer's hod, the handle part being made to fit in the hole of the lathe hand rest base. Near one corner of the square plate a hole is drilled to receive the stud that forms the fulcrum upon which the bar swings. The bar is bent near the end at an angle of 20 or 30 degrees so that the tool may swing through the required 90 degrees without the bar coming in contact with the work at the back of the lathe. On account of the offset of the tool the bar must be held closely pressed to the surface of the plate, and it would doubtless be improved by providing a bridge or cleat to prevent the bar from tilting. In setting up it is of course necessary to have the cutting edge of the tool at the same height as the center of the work and the fulcrum center in line with the lathe centers.

Being on the subject of lathe bar tool holders I will describe one that I made for a 20-inch Lodge & Shipley lathe and which proved a very serviceable fixture. Referring to Fig. 3 *A* is a casting bored at *b* to take a 2-inch round bar, and which also has through the projecting lug a ¾-inch square hole *c*. In the bottom of the casting *A* is planed a groove the same width as that in the compound rest. In this groove is fitted a tongue of machinery steel which is fastened to the casting by two flat head machine screws. I make this tongue removable because on several occasions I found it in the way. A ¾-inch square head bolt *d* serves the double purpose of clamping the round bar and securing the block to the rest. I also made bushings so as to use 1½ and 1 inch bars. The ¾-inch square hole provides for an extra cutting tool, which was generally used for facing and often saved the time of changing tools.

On one occasion I used this holder, as shown in the cut, with a 2-inch round bar carrying three tools; one in front for facing, one for roughing and one for finishing the bore, which was 3



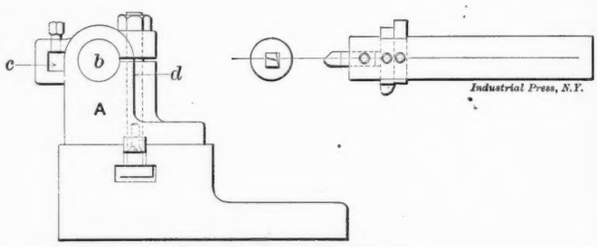


Fig. 3. Compound Boring Bar.

inches in diameter by 2½ inches long. About fifty of these pieces were machined with this rig, which in combination with the feed-changing feature of the lathe produced a result that was an eye-opener to quite a number of men, the average time required being about one-third of their estimates, which were based on old-style methods and tools.

The first operation was to face with the end tool, one cut being sufficient. The front tool was then used for roughing out the bore, working by a line on the cross feed. The second cutter was for finishing, and using the micrometer reading on the cross-feed screw the pieces were rapidly brought to accurate size.

I have heard many men claim that the greatest advantage of the modern lathe is in the quick changes that may be made for chasing, but while that is a very useful feature, I think that the many changes of feed that are at hand for instant use are still more valuable.

When a workman begins a job of turning or boring he starts a cut using the judgment born of experience as to the proper speed, depth of cut and feed. Naturally he endeavors to avoid overloading his lathe, but if he is a good man he can tell whether it will stand more feed, and he adds little by little until he finds the limit, settles just below, and has the satisfaction of knowing that this particular job cannot be done much quicker.

I always like to know the limit the machine will stand,

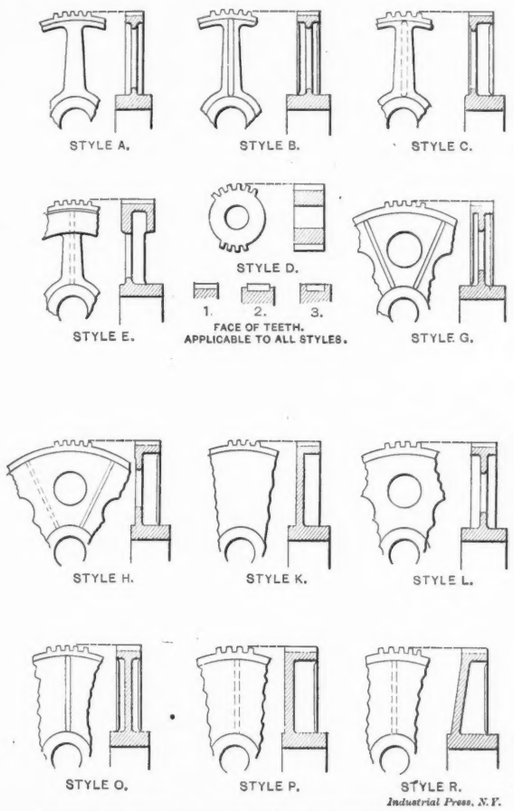
though if the job is a short one it may be best to finish it on your first judgment. If, however, it runs to a half-hour or more, I think it pays to experiment. I remember starting one time to find the limit on rough-turning some soft steel shafts. Formerly they had taken from ten to twelve hours. I spent three days on the job and the average time for each was two and one-half hours, some few being done in two hours and ten minutes. All of which goes to show what can be accomplished by keeping everlastingly at it. A. MERTES.

Emsworth, Pa.

SYSTEM FOR KEEPING TRACK OF GEARS IN DRAWING ROOM.

Editor MACHINERY:

Where there is a considerable variety of spur gears used in the construction of the various machines in a shop the following method of keeping account of them is a time-saver, especially in the drawing room, as it enables the designer to see at a glance just what gears there are patterns for, without going through the various drawings.



System for Keeping Track of Gears in Drawing Room.

The method proposed is to make up a table showing the gears which run together in pairs, and if sketches are made and the various styles designated by letters and numbers, it will be found of convenience. Thus style A has arms in the center of the rim, style B is similar but has ribs to strengthen the arm, and style G has a web or plate with openings and is ribbed. The openings beside reducing the weight are of convenience for purposes of clamping or for inserting drivers when turning. Details 1, 2 and 3 show whether the teeth are unshrouded, shrouded to the pitch line or shrouded to the full depth of tooth. The table shows a gear and pinion, the pinion being shrouded to the pitch line, as shown.

SPUR GEARING.

No. Teeth.	P D	C P.	D P.	Face.	Form.	Style.	Weight.	Dr. No.	Remarks.
60	30″	1.57″	2.	3½″	Involute.	C–1	370 lbs.	..	Machine cut pattern
12	6″	"	"	"	"	D–2	26 "	..	" " "

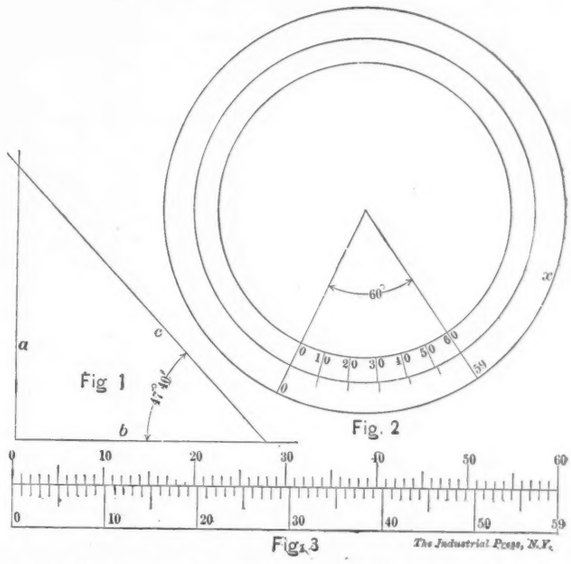
P D stands for pitch diameter; *C P*, circular pitch; *D P*, diametral pitch; *C*—1, style C unshrouded; *D*—2, shrouded to the pitch line. It is of advantage to show the gears which run together in pairs as then the ratio can be conveniently used when calculating for power or speed.

East Providence, R. I. JOHN T. GIDDINGS.

WORKING TO MINUTES WITH A PROTRACTOR.

Editor MACHINERY:

Occasionally one has to work angles down to minutes. There are several ways to do it. One is to lay out the angle on a flat plate, one edge of which is straight, using a table of natural trigonometrical functions to find the dimensions. For instance, lay out the angle 47 deg., 40 min. Take any length for base line, say 5 inches. Find the tangent of angle 47 deg. 40 min $= \frac{a}{b}$, or 1.0977. Therefore $a = 5.4885$ inches.



Lay out line *a* with a square and vernier and scratch a line with a needle stuck in an old penholder. Scratch line *c*, and set the protractor blade to it.

Another way without the aid of trigonometry, is to mark on the outside ring of a protractor, using a milling machine and index-head a division equal to 60 degrees, but instead of dividing it into 60 divisions, like the inside ring, divide it into 59 divisions. Fig. 3 represents it more clearly. The divisions on the lower part are practically 1 minute longer than those of the upper part.

To move the lower part 40 minutes to the right, count 40 divisions on the lower line from the right-hand end and make that division line up with the one marked 20 on the upper row.

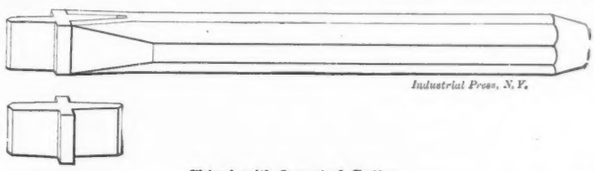
The chief difficulty in this method is the marking and indexing of the 59 divisions, but once it is done it will last a life time. C. W. SHELLY.

New Britain, Conn.

[This, of course, makes a vernier or the usual means employed on instruments for getting small divisions of circular or linear measure.—EDITOR.]

CHISEL WITH INSERTED CUTTER.

We, who are in the machine business, have become pretty well acquainted with inserted lathe and planer tools during the past few years, and everyone knowing them must acknowledge that their use is economical of steel and tool-dressing. But an inserted cutter chisel is another matter and it



Chisel with Inserted Cutter.

would scarcely be regarded as a practical device without good proof to the contrary. However, a British concern called the Patent Stone-Dressing Tool Co., of Sheffield, are making the chisel shown in the cut for engineers, iron founders, etc., which requires no forging, and which is claimed to be a practical substitute for the regular tool that has to be taken periodically to the tool-dresser.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

RUSTLESS SOLDERING SOLUTION.

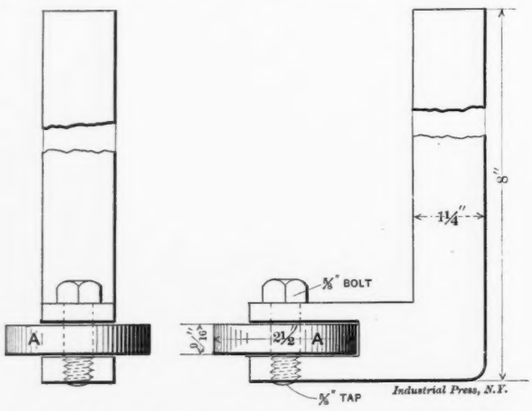
In reply to C. W. B.'s inquiry for a rustless soldering solution I would recommend liquid rosin. It is made by simply adding enough grain alcohol to dissolve the rosin. We use this solution for soldering wire as small as 0.001 inch diameter. It contains no acid that would tend to cause rust. Keep in a bottle well corked to prevent the alcohol from evaporating.

FRANK E. SHAILOR.

Great Barrington, Mass.

TOOL FOR CENTERING WORK ON BORING MILL TABLES

The little tool shown herewith is a handy device for centering boring mill jobs. Suppose, for instance, that it is desired to center up a large heavy ring so as to take a cut off the face, or to center any large heavy piece that is of circular shape. Ordinarily the operator has to take something heavy and bump the job around on the table until he gets it running



true, but with this simple tool clamped in the tool holder and held against the work (on the inside or outside) with the table running, the job can be centered in a very short time. Care must be taken, however, not to push the work on the table too far and to have the wheel *A* in the tool run true.

Monessen, Pa. EARL G. ARNOLD.

METHOD FOR CLAMPING CONTROLLER RINGS FOR FIRST SAW CUT.

These rings were received from the lathe turned, bored and faced, and were then to be cut into various sized segments with thin saws. This part of the work was done on the milling machines, being held in special fixtures, but the rings required an initial cut to receive an index pin in the fixture. For making this initial cut in many rings at one setting I devised the fixture shown below:

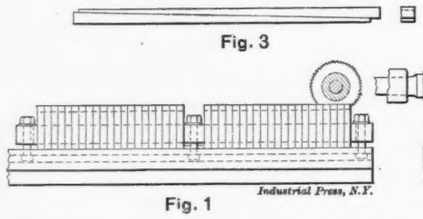


Fig. 3

Fig. 1 Fig. 2

Fig. 1 shows a side and Fig. 2 an end view of the device, while Fig. 3 illustrates the arrangement of wedges for raising the bars to facilitate putting on or removing the rings. As many bars can be used as there are slots in the table of the milling machine. The bars should be as large as possible and allow the saws to clear the bolts. The bolts at the center of the bars pass through holes but at the ends of the bars slots are used instead, so the bolts may be quickly moved away when the rings are to be put on or removed.

R. A. LACHMAN.

Chicago, Ill.

CHEAP MILLING CUTTERS FOR EXPERIMENTAL WORK.

Those who are engaged on model or experimental work are often called upon to make small gears and pinions of special-shaped teeth. The accompanying sketches show two styles of cutters that are well adapted for temporary use and are quickly made. The cutter shown in Fig. 1 is made same as any gear cutter with the exception of backing off for clearance. After the teeth are cut the slots *A* are sawed back of the teeth and the clearance for the cutting points is obtained by setting the teeth back as at *B*, thereby doing away with the slow process of backing off each tooth.

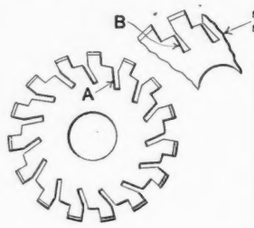


Fig. 1.

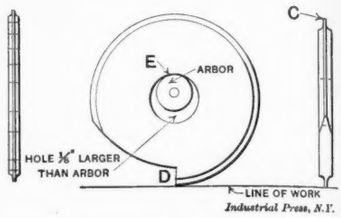
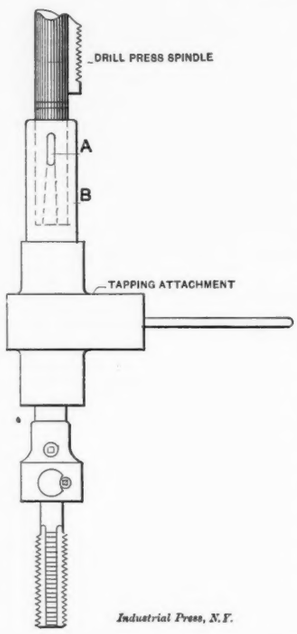


Fig. 2.

Fig. 2 shows another form which in the writer's opinion is more practical and considerably easier to make. It is a plain blank having a hole ⅛ inch larger in diameter than the arbor upon which it is to be used. The edge *C* is turned to the desired shape and cut in as at *D* to make a cutting point. When in use the cutter is set as at *E* so that cutting point is highest. This style of cutter will produce very satisfactory work and can be ground on the face of cutting point without materially changing shape.

F. E. S.

FOR HOLDING TAPPING ATTACHMENT TO DRILL HOLDER.



Having read several articles in MACHINERY on different ways and methods of holding tapping chucks securely in drill press spindles, all of which are not very effective, especially when doing heavy tapping, I enclose a sketch of a tapping chuck and method of securing same to an ordinary drill press spindle, which will be readily understood.

The sleeve *B* takes the place of the usual taper shank furnished with the chucks and is made an easy fit over the drill press spindle with an oblong hole to match drift slot in the spindle and is held in place with the key *A*. The sleeve is easily made and does away with the annoyance of the chuck continually falling out and the expense of twisted tangs and ruined spindles.

C. BARDON.

Anaconda, Montana.

HOW A BASTARD FILE WAS USED FOR KNURLING.

I was once working in a small contract shop—one of the shops in which every imaginable kind and sizes of jobs are done on a lathe of a swing somewhere between 12 and 36 inches. Well, one day the manager, superintendent and general foreman (who was also the owner) came down in the shop and told the foreman and shop crew (that was me) he wanted one dozen 1½-inch nuts, twelve thread. They were to be round on the outside and 2½ inches in diameter. He said they were to be used as hand nuts and that I should file notches on the outside or rough them up some way so as to furnish a hold for the fingers.

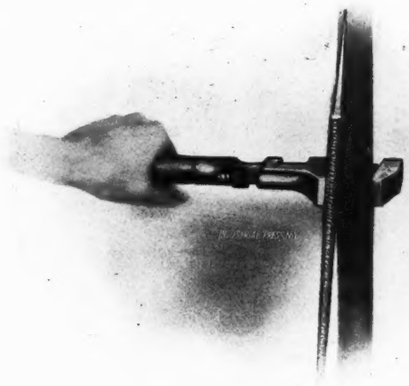
I found a piece of cold rolled shafting 2½ inches diameter

and about 6 feet long, chucked one end in the lathe and let the other run in the steadyrest. One end was bored and threaded of a sufficient length to make three nuts. I then laid a block of wood across the lathe carriage, put a long parallel bar on the timber, then two short rollers and another parallel bar which came within about 3-16 inch of the bottom side of the work. I then hunted up an old bastard flat file and placed it on top of the last bar and loosened the top screw in the steadyrest just enough to allow the point of the file to roll in under the end of the shaft. The lathe was then turned by hand backward and forward, at the same time increasing the pressure with the screw at the top. I found that this made an excellent job of knurling and after cutting those nuts off you could not tell them from "store bought."

C. P. L.

AN EXTEMPORIZED PIPE WRENCH.

At one time I had the pleasure of helping a neighbor out of his troubles by a little "dodge" in the mechanical way, and thinking it would benefit many of your readers I will tell you about it.



It so happened that my neighbor found a bad leak in his water pipes in the house one evening, and it became necessary for him to take some of them apart in order to get the repairs from the city. Not having any pipe-wrench he called upon me to help him get the pipes apart, or else to lend him a pipe wrench, but I had no pipe-wrench, so I asked him if he had a monkeywrench. He replied that he had, whereupon we took a 10-inch round file and setting the jaws of the monkeywrench up to within about ⅜ inch from the pipe we placed the file in between them in the manner shown on the cut. By pulling so the file tended to roll in between the pipe and the wrench jaw, we were able to loosen the pipe.

I also find that this scheme works very nicely on any sort of round iron or on studs, etc., as well as on pipe.

Pearl River, N. Y. H. E. Wood.

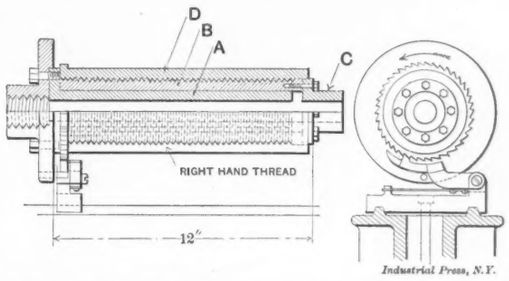
[The writer worked for a few weeks some years ago in a new railway repair shop in Northwestern Pennsylvania; all tools were scarce but the scarcest were pipe-tongs. The consequence was that the men were forced to resort to the above kink whenever any pipe work had to be done. The common practice was to go to the storeroom, get a new file and break it into short lengths, which were used on that job but not saved. On the next job another new file would be sacrificed, and so on. It seemed like a very expensive and inefficient way to get along without the proper tools; it is, however, a good kink to know when an emergency arises.—Editor.]

BORING FIXTURE FOR MOTOR CASTINGS.

Being obliged to do on my 14-inch x 6-foot engine lathe all of the drilling and boring upon a pair of gasoline motors, I made up the fixture described below and it has enabled me to do the work very nicely. The automatic feed I have not yet tried, but used instead a large wood clamp for retarding the revolution of the outer shell or nut, keeping it only tight enough to give the required feed.

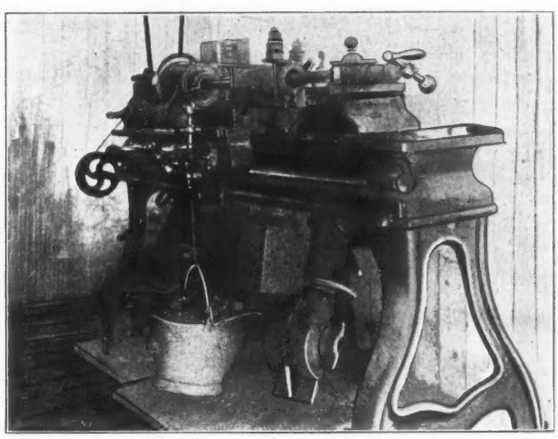
Referring to sketch, it will be seen that the inner piece or spindle *A* is let into the faceplate to keep it central and is secured thereto by bolts; it also has a keyway cut its full length.

The center piece or screw *B* is a sliding fit on the spindle and is provided with a key to fit the keyway in same. *C* is the socket for holding the drills or boring bars and is fastened to the end of *B* by cap screws, as shown. *D* is an outer



sleeve or nut and is threaded to fit the screw *B*. If this nut *D* is made to rotate slower than the lathe spindle the screw *B* is necessarily forced out as the key prevents turning on the spindle *A*. By using a steady rest on the bar a traverse of 8 or 10 inches can be had.

I inclose a print showing one of the pieces for this fixture clamped to the carriage of the lathe for boring. This photograph may be of interest for the following reasons: First, the carriage of the lathe is not gibbed down, which accounts for the hod of coal and motor casting hung thereto. Second,



at the time it was taken the lathe was situated in the cellar with two ordinary small windows on the east side. The shutter was opened at two o'clock on Sunday and the plate left exposed until two o'clock the following day, no artificial light whatever being used. W. T. Sherman.

Providence, R. I.

CATHEAD FOR STEADY-RESTING SQUARE BARS.

Some time since while working in a small shop some axles of three-inch square steel were sent in to have the ends turned round. There was only one small lathe in the place

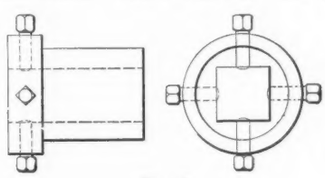


Fig. 1

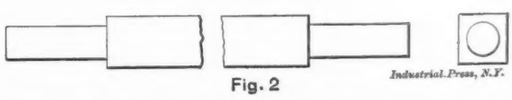


Fig. 2

and that was too short to take the pieces between the centers.

A 3-inch square hole was drifted through a piece of round stock which was then turned down for the greater part of its length so that the steadyrest would take it in. Four holes

were drilled and tapped for setscrews equidistant around the flange and this was then clamped upon one end of the axle and run in the steadyrest, the other end of the axle being held in the chuck. By this means the ends were readily turned round

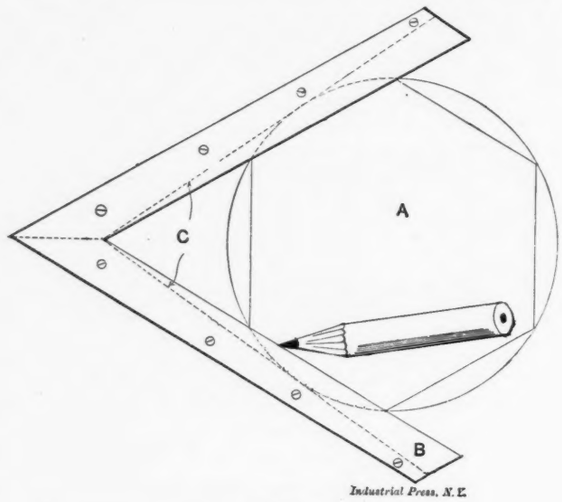


Fig. 1.

for the required six inches. Fig. 1 (previous page) shows the bushing or cathead, and Fig. 2 the finished axle.

McKeesport, Pa. J. J. DAWSON.

TOOL FOR LAYING OUT HEXAGONS.

The cut, Fig. 1, shows a very useful tool for patternmakers for laying out hexagons on the ends of rounds, such as hexagon cap nuts, etc.; it saves the time of spacing around and is just as accurate. I made the tool I use as follows:

B is cut from a brass plate (steel would be better) and the

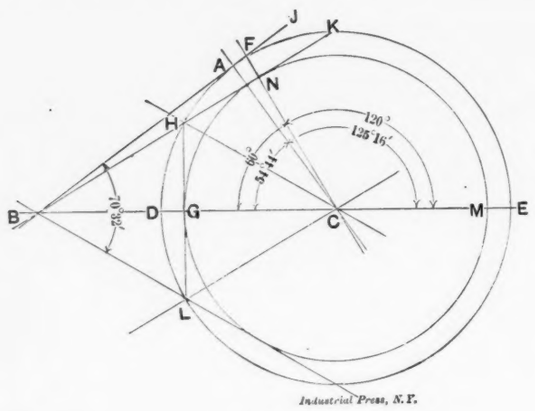


Fig. 2.

included angle must be exactly 60 degrees. Fastened to its under side by flat head screws are the two wooden pieces *C* which bear on the circumference of the turned piece when the gage is being used. These pieces must form an included angle of exactly (?) 70 degrees. Although I have been using this tool for years I have never seen another, and for this reason think it may be of interest to others.

St. John, Canada. V. W. DYKEMAN.

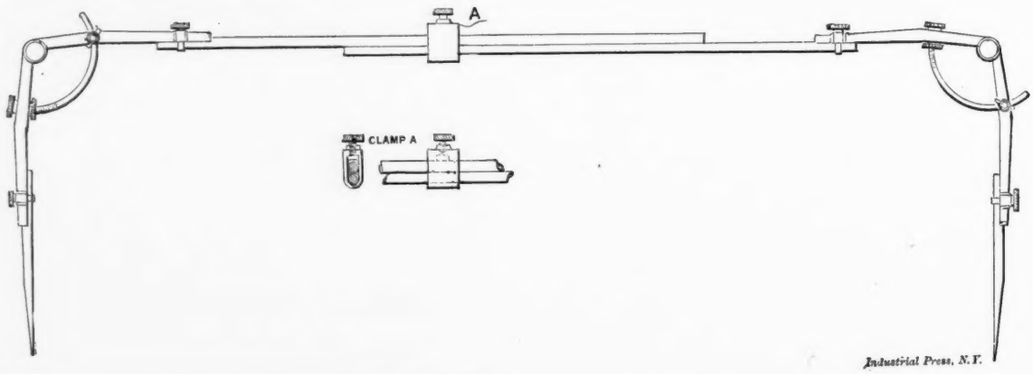
[The included angle between the wooden sides *C* should not be exactly 70 degrees, although this figure is so nearly the exact one that it will answer most practical purposes. The exact angle is 70 degrees 32 minutes, and was determined as follows:

In the construction, Fig. 2, *H L E* represents the circle in which the hexagon is to be inscribed, *G N M* is a circle inscribed within the hexagon, and *B E* is the projected diameter of both circles. Of course we know that a hexagon can be divided into six equal triangles like *H C L*. The three sides of *H C L* are equal and the interior angles are each 60 degrees. The side *H L* is divided into two equal parts, *H G* and *G L*, by the diameter *B E*. The angle *H B L* equals 60 degrees, and *B E* bisects it. *B A C* is a right angle.

$$BG = GC$$
$$BC = 2\,GC$$
$$HG = \tfrac{1}{2}\,HC$$
$$\overline{GC}^2 = \overline{HC}^2 - \tfrac{1}{4}\overline{HC}^2 = \tfrac{3}{4}\overline{HC}^2$$
$$HC = AC, \text{ therefore}$$
$$\overline{GC}^2 = \tfrac{3}{4}\overline{AC}^2$$
$$GC = \sqrt{\tfrac{3}{4}\overline{AC}^2}$$

making $BC = 1$, then

$$2\,GC = 1, \text{ and}$$
$$2\sqrt{\tfrac{3}{4}\overline{AC}^2} = 1$$



$$4 \times \tfrac{3}{4}\overline{AC}^2 = 1$$
$$3\,\overline{AC}^2 = 1$$
$$\overline{AC}^2 = \tfrac{1}{3}$$
$$AC = \frac{1}{1.732} = .5773$$

.5773 is the sin $\angle$ 35° 16′

2 (35° 16′) = 70° 32′, or $\angle$ *A B L*

EDITOR.]

DIVIDERS CONVERTED INTO TRAMMELS.

Mechanics in general will be interested to learn how I contrived to get along without buying a pair of trammels. The cut clearly shows the scheme. I was in the habit of borrowing those of my neighbor, till he was tired, and finally told me I would have to "cut it out." "Necessity being the mother of invention," I was forced to devise what you see.

Having two pairs of Starrett's combination dividers I selected a few pieces of 5-16-inch wire from the company's best stock, and when the boss was not looking I did a little "government work" on the clamps. I made two clamps, one for short, and two for long range. There seems to be no limit to this tool in the matter of adjustment, and it is found very handy.

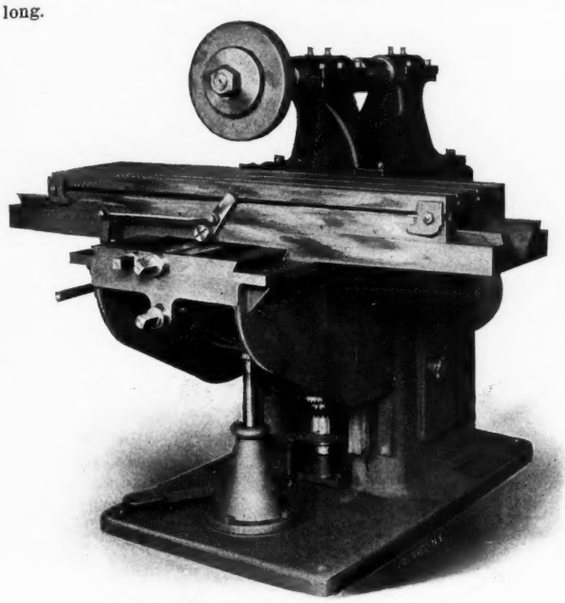
Holyoke, Mass. C. W. PUTNAM.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

SURFACE GRINDER.

We illustrate below a new surface grinder just brought out by the Goddard Machine Co., Holyoke, Mass. This machine is for finishing dies, brick molds, and for a large variety of flat work. As will be seen, the construction is powerful and durable. The machine takes work 12 inches wide and 42 inches long.



Surface Grinder, Goddard Machine Company.

The steel spindle, 2¼ inches in diameter, is turned and ground accurately and runs in bearings of ample dimensions to give it the required support. It is provided with a fiber thrust collar and nuts to take up the wear. The bearings are adjustable, self-oiling and dust-proof. The table has three T-slots for clamping the work, and, as shown in the cut, power longitudinal feed. Power feed can be applied to the transverse motion when required.

All three motions of the table can be operated by hand, using the same crank handle for each. Power feed is obtained by throwing in the clutch; the power transverse feed operates in either direction or may be thrown out to allow hand feed. The knee has a vertical adjustment of 10 inches.

The principal dimensions are: Height from floor to center of spindle, 48½ inches; length of spindle over all, 41½ inches; size of table, 12 inches by 48 inches; base, 30 by 50 inches; size of wheel, 12 inches by 1½ inches; speed of countershaft, 290 revolutions. The machine complete weighs 3,000 pounds.

COLD SAW CUTTING-OFF MACHINE.

The half-tone herewith illustrates a cold-saw cutting-off machine, for operating on crankshafts, recently brought out by the Newton Machine Tool Works, Philadelphia, Pa. The photograph shows the machine set up with crank in position, as it was tested before leaving the shop. As finally completed for use the machine is supplied with V-blocks for supporting the shaft between the cranks instead of the temporary blocking shown in the illustration.

The spindle of this machine is extended so as to carry two saw blades, making both cuts at one time. To accommodate the varying width of throats the spindle is fitted with a number of washers or collars which are made of various thicknesses. The blades are keyed on the spindles; in addition there are four driving pins for each blade. The spindle is driven through gearing by a phosphor-bronze wormwheel and hardened steel worm of steep lead. The carriage has variable automatic feed by means of friction disk and power quick return, both of these movements having an automatic throw-out.

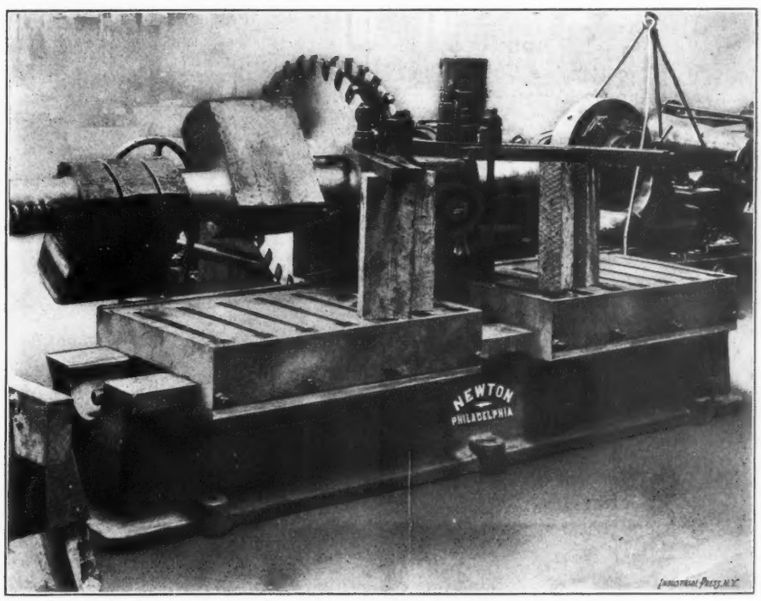
The work tables are arranged so that if the machine is used with only one saw blade, both cuts can be made without unclamping the work. When one blade is used the crank is set on the V-blocks and the carriages adjusted the proper width apart. The crank is then clamped, and after the first cut is made the tables are moved along the bed simultaneously. Carriages are clutched so that they can be operated either independently or simultaneously.

The machine carries either one or two blades, as desired, 36 inches diameter, and will cut to the depth of 11½ inches. It can also be used for round or square stock up to this capacity. The web of the crank shown in the cut is 8¼ inches wide; the blades, which are 9-16 inch thick, were set 5¾ inches apart, the depth of cut being 5⅝ inches. The periphery cutting speed of the saws is 55 feet per minute.

The stock used in this crank was exceptionally hard forged steel of about .47 carbon.

AUTOMATIC RACK-CUTTING MACHINE.

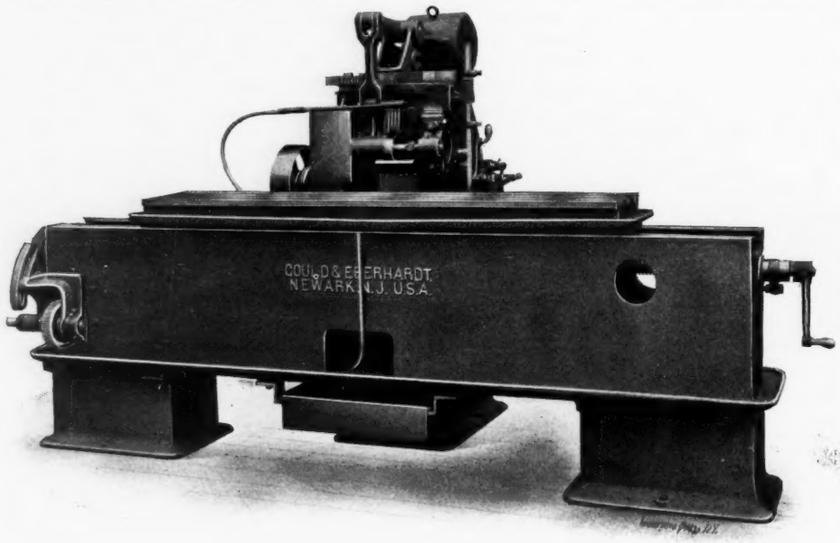
We show on the next page a half-tone of a new rack-cutting machine recently brought out by Gould & Eberhardt, Newark, N. J. The cut shows a front view. This machine is intended for light work, such as for small printing press racks, notching scale beams, and similar work, where great accuracy is required. It has a capacity for cutting racks as coarse as 3-pitch, using a gang composed of one roughing and one finishing cutter, placed side by side; 6-pitch with a gang of three finishing cutters; 8-pitch with four cutters, etc. The gang cutters used on these machines have their cutting points set spirally, and thus avoid chatter and rapid dulling of the edges. The working sides of the blanks are clamped vertically so the cutter slide travels vertically. A funnel-shaped receptacle or opening under the cutters receives chips, oil, etc., which are carried to the bottom of the machine, where the oil is separated and pumped again to the cutters. The



Newton Cold Saw Cutting-off Machine.

cutter slide is counterbalanced and so arranged that it cannot possibly feed downward unless the proper divisions and all previous movements have been completed. The machine can also be arranged to operate semi-automatically if desired.

By an ingenious arrangement on the end of the machine, it



Rack-cutting Machine, Gould & Eberhardt.

can be set to divide for either circular or diametral pitches, using the same lead or dividing screw. It can also be arranged for metric divisions instead of English inch measurements when desired. The cutter spindle is geared very strongly, and as it is driven by worm and wormwheel, affords a very smooth and steady drive. The top of the table is T-slotted, and, with vises for holding the rack blanks, affords a means for cutting any thickness or specially-shaped rack within the capacity of the machine. Any length of rack can be cut by resetting, and the table can be geared to use the traveling movement in either direction, saving wear on the various parts, and obviating the necessity of returning the table every time a new blank is set. The table stops automatically at each end. This light pattern machine is made in 4, 6 and 8-foot lengths.

BOLT CUTTER.

A new bolt cutter has been placed on the market by the Landis Machine Co., Waynesboro, Pa. Mr. A. B. Landis, the patentee of the machine, has spent several years in its development and has embodied new principles in its design. The

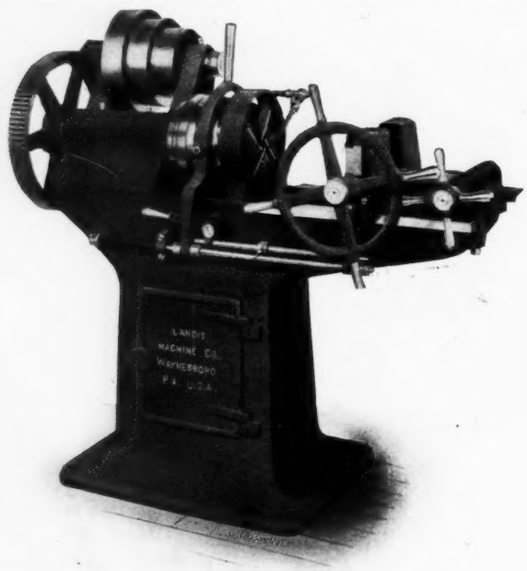


Fig. 1. Landis Bolt Cutter.

details of the whole machine have been carefully worked up, and it is provided with a carriage of improved form, an improved vise, positive oil pump, etc.; but the chief features relate to the die, which is unique in its conception and produces results that are seldom approached in thread cutting except by the use of the leadscrew on a lathe. The die has four chasers which are made from flat pieces of steel, and the teeth forming the threads are milled on the flat sides of the chasers and extend their entire length, as shown in Fig. 2. This gives a uniform shape to the teeth throughout the chasers and enables the latter to be ground repeatedly without in any way affecting their accuracy or the shape of the threads which they cut. The cutting of the threads is done by the ends of the chasers, and the grinding is done on the ends of the chasers also. The chasers are held in grooved blocks which are secured to four oscillating spindles, which latter are geared together in the head and made to simultaneously open and close the die when adjusting it to the proper size. The blocks and chasers are interchangeable.

The die requires no annealing or hobbing, no retempering, and need never be ground in the throat, inasmuch as the latter is formed by beveling the ends of the chasers their entire length, so that the die is always provided with a throat, however much the chasers may be ground off. The life of this die is many times that of a hobbed die.

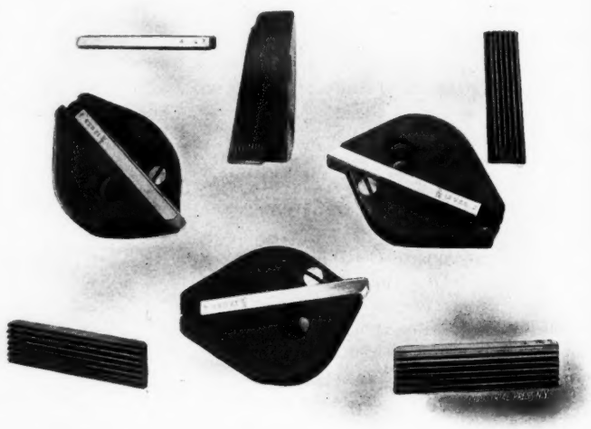


Fig. 2. Chasers used on Landis Bolt Cutter.

In manufacturing the chasers the teeth and throat are milled with special machinery, and care is taken to avoid distortion in hardening. When the chasers are placed in the machine they stand out in front of the head, which allows the chips and scale to fall outside the head where they will not get into the running parts. The chasers are set on lines tangent to the bolt, which gives an ideal clearance, and at such an angle with the thread that the cutting will at all times be done by the front teeth, while the back teeth simply bear against the work and form a permanent lead nut to guide the die. The result is that threads of great accuracy are produced, a piece having been threaded 4 feet long which did not vary more than 1-100 of an inch in pitch in its entire length.

The leading qualities of the die are shown by example 4, in Fig. 3, which is of a ¾-inch rod which was cut down to 5-16 inch diameter and threaded at the same time, without seriously changing the pitch of the thread.

To a limited extent a die of a certain pitch can be set to cut different diameters; for instance, the ⅞-inch die, with 11

threads to the inch, can be set to cut 11 threads on any size between ⅜ inch and 1 inch in diameter. The specimens 1, 2 and 3 in Fig. 3 show a number of operations of this kind, all produced with one die.

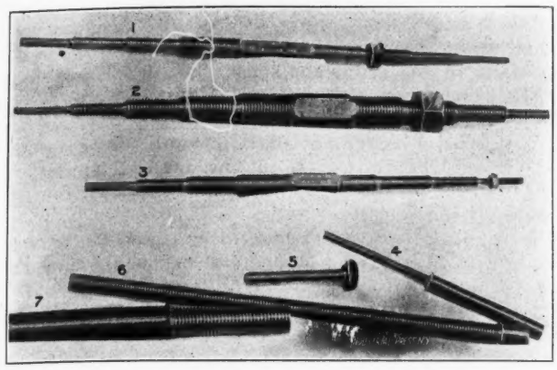


Fig. 3. Specimens of Thread Cutting. Nos 1 to 3 were all Cut with One Die.

As previously stated, four blocks containing the chasers are secured to four oscillating spindles, which latter are geared together by means of a central spindle upon which teeth are cut. In the sectional view, Fig. 4, *B B* are the spindles to

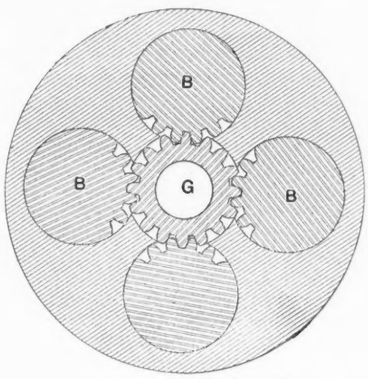


Fig. 4.

which the die blocks are attached, and *G* is the central spindle, made hollow to admit of stock passing through. The rotation of the center spindle *G* causes the four outer spindles to rotate corresponding amounts and the cutters carried by the die blocks to move in or out from the work, as the case may be. There are arrangements for imparting both a slow and rapid motion to the spindle *G*, the former for accurate adjustment of the die and the latter for opening or closing the die by hand or automatically by the movement of the carriage.

The mechanism is illustrated in Figs. 5, 6, and 7, the latter showing two different half sections of the die head, one above the center line *A B*, and the other below. Fig. 5 is a cross section on the line *E E* of Fig. 7, and Fig. 6 a cross section on the line *F F* of Fig. 7.

At the left end of the center spindle *G*, Fig. 7, is attached a wheel *H*, having teeth cut in its periphery to mesh with a rack *T*, Fig. 6. This rack is carried by a recess in an outer ring *I*, and can be adjusted longitudinally in the recess by the screw *S*. This gives the fine adjustment to the chasers through the center spindle *G* and the four outer spindles to which the die blocks are attached.

The rapid opening and closing of the die is effected by means of the toggle levers, *M* and *N*, Figs. 5 and 7. One of the levers is pivoted to the outer rotating ring *I* and the other to the body or fixed portion of the die. The opening and closing of this toggle joint is effected by the pinion *P* and the sliding rack *Q*, Fig. 7. The rack *Q* is attached to the sleeve *J*, which slides on the outside of the die head and is moved backward or forward, as the case may be, by a yoke, after the usual manner in machines of this character. A movement of the sleeve *J*, therefore, in either direction causes the toggle joint to move the ring *I* sufficiently to either open or close the die. When

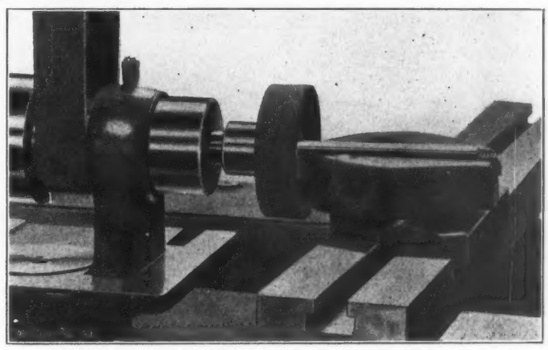


Fig. 8. Grinding the Chasers.

the toggle levers are in a straight line, as in Fig. 5, the chasers are locked securely in the position for cutting the threads. Means are provided for so changing the pivot points of the toggle levers as to adapt the die for cutting either right-hand or left-hand threads.

The die blocks are easily attached to or removed from their spindles and the chasers are held in the blocks by means of

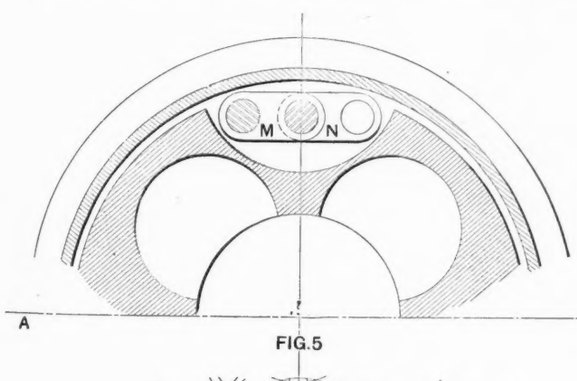


FIG.5

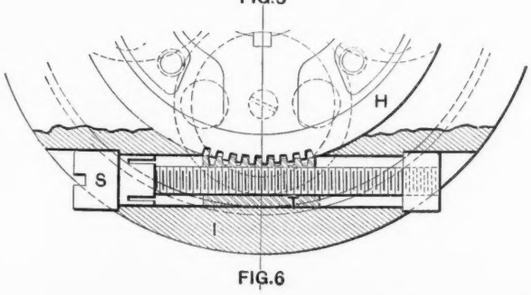


FIG.6

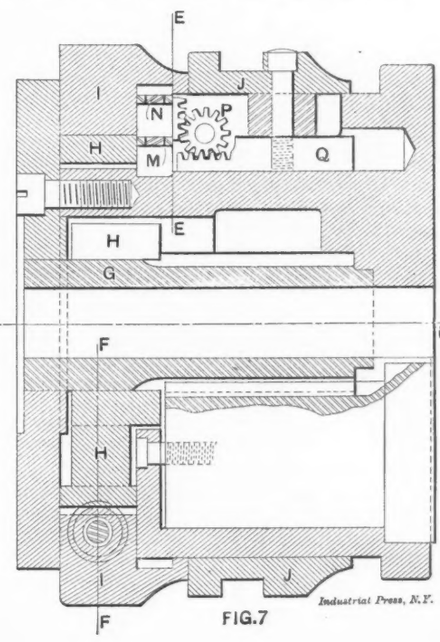


FIG.7

screws which have annular grooved heads to match the pitch of the chasers. These grooves engage the teeth of the chasers and draw them to a seat in the bottom of the slot, as well as press them against the sides, making the chasers rigid with the block.

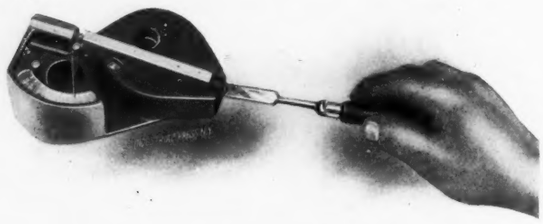
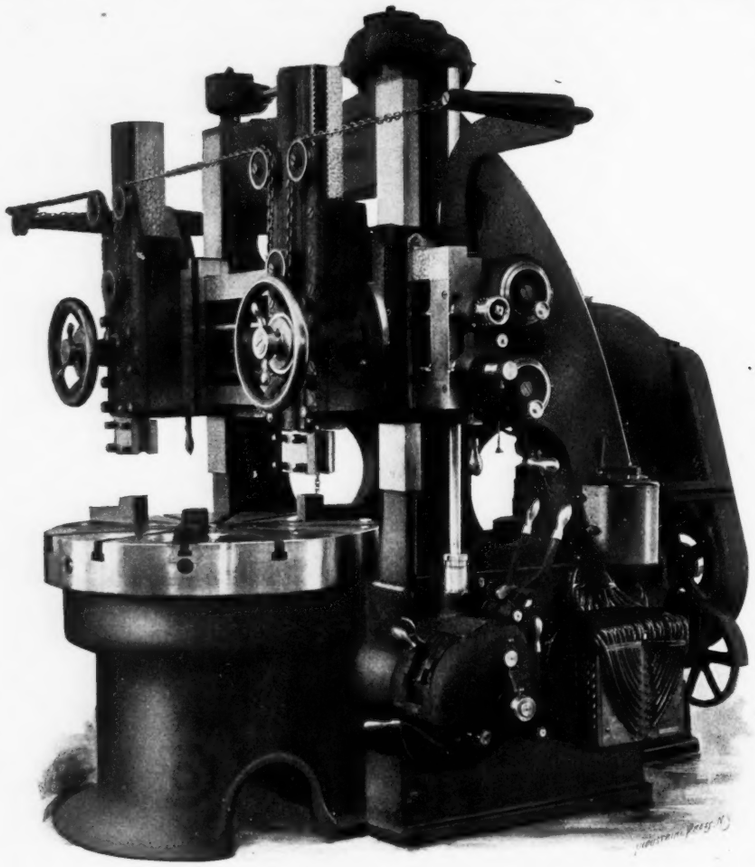


Fig. 9. Adjusting Chaser in Die Block.

Fig. 8 shows a device for grinding the chasers, which needs no explanation; and Fig. 9 shows how, after the chasers are ground, they are again set so as to secure the proper size. The chaser fits in a block and is pushed forward against the pointer of the instrument in Fig. 9 until it registers the required diameter, when it is clamped in position.

GISHOLT BORING MILLS.

A new type of boring mill has been placed on the market by the Gisholt Machine Company, Madison, Wis. This company have heretofore been closely identified with the manufacture of heavy turret lathes and the experience gained in that field has resulted in new features of design which have been embodied in their boring mills. The general features of the lathe headstock used by them, which is of the friction type, back-



Boring Mill of entirely New Design, made by Gisholt Machine Company.

geared and very powerful, have been incorporated in the boring mills. This type of headstock in its adaptation to boring mills we believe to be new. It has proven very successful in the lathes, and experience shows that it is equally well adapted for the boring mills. It not only gives an efficient drive but is extremely simple and handy of operation.

Six mechanical changes of speed are obtainable by it and twelve table speeds are given. A lever within easy reach of the operator (as in fact all operating levers are within easy reach) gives absolute control and by reason of the friction device enables the operator to start or stop the machine without touching the motor or shifting a belt. It seems to be a fact that for direct-connected machines there is a decided leaning toward some friction device introduced between the motor and the driving mechanism. By this method much of the time taken up by starting and stopping the motor or shifting the belt is done away with.

If motor drive is used on the Gisholt mill, the motor is mounted directly on the headstock, giving a close connection and at the same time a convenient one, and one that does not necessitate any additional floor space, an important consideration in crowded shops.

The cross rail is raised or lowered by power, the lever for operating the same being located just behind the feed gear boxes. The heads are independent, having separate feeds, both vertical and horizontal, and each is controlled from its own side of the mill. The heads, of course, may be swiveled to any angle. Positive stops are provided so that the down slides may be brought to coincide directly with the table center. By a friction device in the feed mechanism any injury to the heads or gears resulting from their collision is averted. This device will often prove of much value, especially where there is any tendency toward carelessness in operation.

The down slides of this mill are of a particularly stiff and rigid construction, broad bearing surfaces being provided and taper gibs inserted to take up any wear.

A simple time-saving device lies in the micrometer index dials with which both feed screws and feed rods are fitted. While the micrometer index dial has been used on other machines, its application to the feeds of a boring mill is a new thing as far as we know. These dials read to .0010 inch, and in consequence naturally reduce the amount of measuring and calipering to a minimum. Another device in connection with the feeds lies in the feed tripping dials, which may be seen in the illustration at the end of the cross rail. By means of these dials the feeds may be set to trip at any point desired, and by an automatic arrangement will trip at that point when it is reached. A range of ten feeds is given on both vertical and cross feeds, any of which is instantly obtainable.

The right-hand head may be removed and replaced by a turret head. Either the regular head or turret head may be fitted for screw cutting if desired. The spindle is self-oiling and rests on a very broad beveled, babbitted surface, the drive being of the spur pinion variety and powerfully geared. The table may be a universal chuck fitted with movable top jaws, or, if desired, a faceplate with independent jaws may be substituted. At the present time these mills are manufactured in six sizes, ranging from 34 inches to 74 inches

AUTOMATIC GEAR-CUTTING MACHINE.

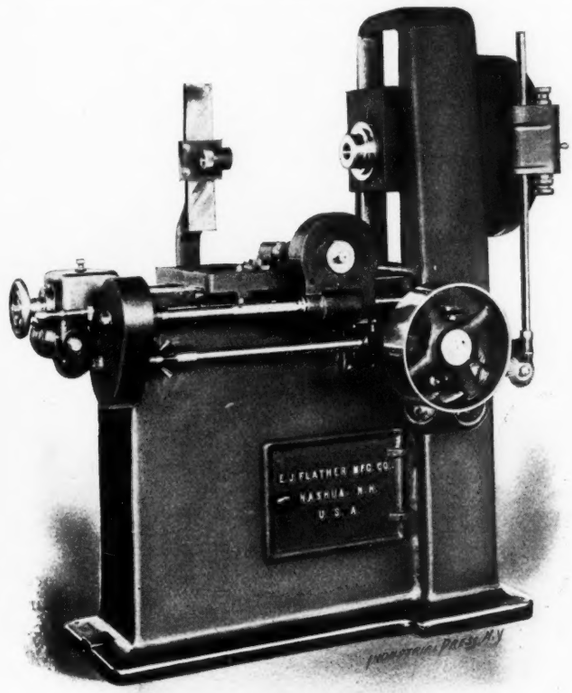
This gear cutter has been designed to meet the requirements of modern plants for a powerful machine, capable of very high speed The tool, as will be seen in the illustration, is heavy, well proportioned and so designed as to do its work without jar or chatter; while the gears cut—either fine or coarse pitch—are perfectly smooth. Complicated movements have been avoided, each different mechanism being simple in design and positive in action. This machine cuts spur gears to 30 inches in diameter, 9 inches face and 4 diametral pitch. It is also built to cut spur gears 36 inches in diameter.

The head carrying the work spindle is clamped, after the work has been adjusted, by simply drawing forward a lever. The housing is so constructed that in binding the head it is clamped as if solid, yet cannot cramp the work. The head is

raised by a screw driven by means of two planed bevel gears and a handwheel located on the side of the machine. This has micrometer adjustment graduated to thousandths of an inch.

The work spindle is a large crucible steel forging bored to fit a No. 12 Brown & Sharpe taper. The carriage has wide bearings on the column, is well gibbed and provided with felt wipers, which prevent the chips and dust from scratching the bearings.

The cutter spindle is hardened and ground, runs in a phosphor bronze sleeve, and ample provision is made for taking up



Automatic Gear Cutter made by E. J. Flather Mfg. Company.

wear. One cutter arbor is furnished, which is hardened and ground and has a strong outer support. A special feature of this gear cutter is the device for locating the cutter centrally with the work, enabling the cutter to be quickly and easily adjusted and clamped in position. The cutter spindle is driven by a powerful worm and worm gear, constantly running in oil, so that all jar and chatter, as the cutter enters the work, is eliminated. The return of the carriage is very rapid, reducing the time taken for both returning and indexing. This return motion is constant and in no way affected by changing the speeds or feeds.

The length of cut is regulated by sliding dogs easily adjusted, arranged in such a manner that the carriage may be run back clear of the work without disturbing the dogs. The indexing mechanism is positive in its operation, strongly built, operates without jar, and is locked after each index is made. It is impossible for it to operate after the cutter has entered the work, or to index more than the space for which it is set. The indexing is not affected by any change of speed. The worm driving index wheel can be disengaged from the driving rod by a fine tooth clutch, the work revolved in either way, and the clutch re-engaged. This clutch obviates slipping. The driving pulley runs 300 revolutions per minute, but the indexing as well as other operations on the machine can be made by pulling the belt very slowly by hand. None of the motions of the machine depend on momentum to complete their movement, or friction to carry them. Both the work arbor and cutter arbor are drawn into taper sockets by drawbolts, which also eject them. All cylindrical bearings are ground, and flat bearing surfaces are scraped to surface plates. The machine complete weighs 2,500 pounds. It is built by the E. J. Flather Mfg. Co., Nashua, N. H.

BECKER-BRAINARD FOURTEEN-INCH CUTTER AND REAMER GRINDER.

The cutter and reamer grinder shown in Fig. 1, and doing characteristic work in Figs. 2 to 5 inclusive, is being manufactured by the Becker-Brainard Milling Machine Company, Hyde Park, Mass., to fill the want for a machine capable of grinding heavy cutters of large diameter and long face, such as are used on large column and planer-type milling machines; also for conveniently handling large diameter inserted tooth face cutters. The machine will handle all styles and ordinary sizes of cutters, including plain, straddle, form and end mills, etc. Unlike most other grinders it requires no extra fixtures for handling any style of cutter or reamer. It has two separate work columns, each provided with its own slides. The cutter is transferred from one to the other for the different operations on the side and end teeth.

The main work column has a knee with saddle and table having 6 inches vertical adjustment. The saddle and table swivel around the column in either direction. The column is grad-

Fig. 1. New Cutter and Reamer Grinder, adapted for Large Milling Cutters of all Types.

uated so that setting can be quickly made for proper clearance with different diameters of emery wheels. The table is fed by rack and pinion, having a longitudinal feed of 20 inches and a cross feed of 7 inches. It is provided with a graduated swivel head which carries a bar on which to mount the cutters.

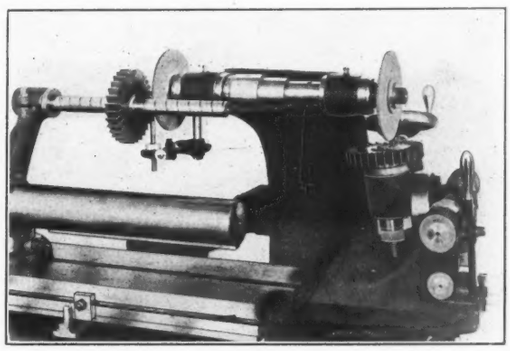


Fig. 2.

The cutters are preferably ground by sliding them on the bar in front of the wheel, as this insures the cutting edge being straight and true with the hole.

The auxiliary column with slides, at the side, is provided so as to make unnecessary the special fixtures usually required, and, as it is always at hand, no time is lost in setting up for jobs out of the ordinary run. The second column has a swivel

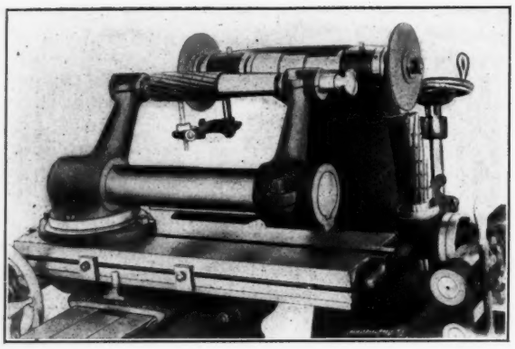


Fig. 3.

carriage carrying two cross slides, the top slide having 7 inches traverse and the lower one 9 inches traverse at right angles. The top slide carries a swivel head or holder sliding on a horizontal bar which permits 5 inches traverse. With this fixture,

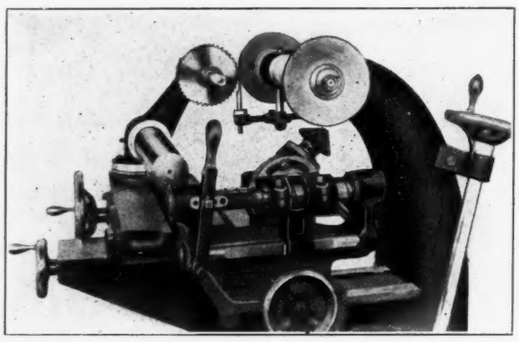


Fig. 4.

which is used for grinding the end teeth of mills and cutters, it is unnecessary to use any other but the 7-inch emery wheel shown in the cuts.

Fig. 1 shows the belt-driven machine; it is also made electrically-driven, in which case the motor is mounted on the back of the frame column and is belted up to a countershaft secured to column by brackets, so that it stands some distance above the grinding spindle. From the countershaft a belt, of course, leads to the grinding spindle pulley. Advantage is taken of the countershaft brackets for a convenient location for the starting box or rheostat. One of the electrically-driven machines is being shown at the St. Louis Exposition.

Figs. 2 to 5 inclusive show some samples of work done. Fig. 2 shows the machine grinding the ends and sides of straddle mills; Fig. 3 of end and side cutting mills. Fig. 4

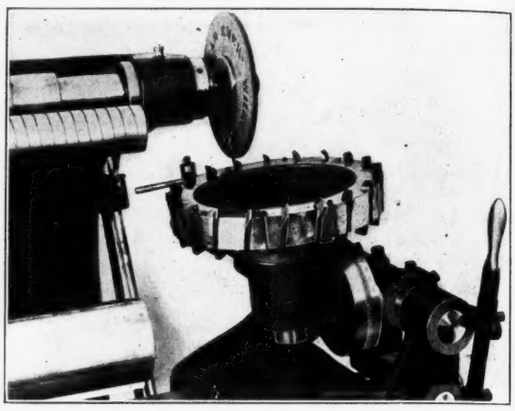


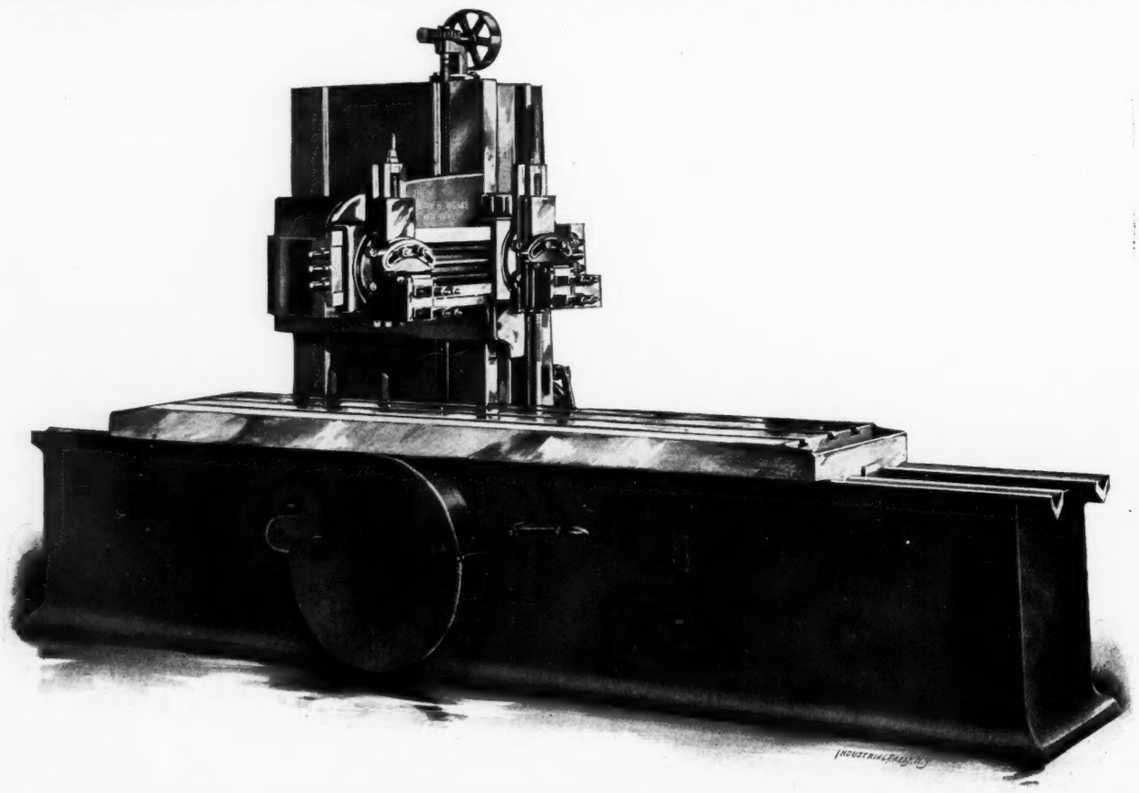
Fig. 5.

shows a slitting saw on the grinding bar and the auxiliary head at the side swiveled for grinding the teeth of a bevel mill. Fig. 5 shows a large inserted tooth face mill in position on the sliding head. This is a difficult cutter to handle on most grinders without special fixtures, but on this machine it is a simple operation.

OPEN-SIDE PLANER.

The features of the open-side planer here described are simplicity of construction and rigidity to meet the increased strains of modern work. The tool is made box section throughout.

The bed is cast closed on the upper surface and is ribbed at intervals, there being three cross partitions opposite the base of the column, which is itself cast solid with the bed up to the level of the table. The upper column, which is box section, rests on broad flanges and is secured to the base.



Open-side Planer made by Cleveland Planer Company.

The Vees are 100 degrees, giving ample bearing and ease of running. Oil pockets are provided with automatic oilers carrying the oil to the top of the Vees, insuring perfect lubrication. The cross rail is square gibbed, both front and back, the front gib being cast solid with the rail.

The larger sizes of this machine are equipped with side heads, which operate independently of cross rail heads, and with the cross rail removed can be operated to the full height of the column. All the gears are encased. Feeds are all automatic in all directions, and can be operated from either side of the machine. No part of the machine extends below the floor. The belt shifting device is simple, shifting one belt at a time without shrieking. The table return is from 2½ to 1 to 4 to 1, as desired. The drive can be set either parallel with or at right angles to the bed, and the machine is adapted to either belt or motor drive. It is built in sizes 30, 36, 42, 48, 54, 60 and 72 inches, and any length, by the Cleveland Planer Co., Cleveland, O.

PRECISION BORING, DRILLING AND MILLING MACHINE.

The foundation principle of this machine, as in the larger one made by the same company, the Lucas Machine Tool Company, Cleveland, O., is raising and lowering the spindle head, and with it the outer support for the boring bar, which is a constant weight, instead of the platen, with its load, which is widely variable.

This construction also makes possible the use of an exceedingly deep box bed, resting on three points, thus eliminating the necessity and expense of a foundation for the machine, and incidentally making it a matter of small expense to set the machine in a new location, if desired.

The yoke carrying the outer support for boring bar is fitted to the bed and easily adjustable by a wrench to any point desired along the bed. Pieces of work longer than the nominal range of the machine may be drilled and milled and holes of such a length that the outer support for boring bar is not needed may be bored, by simply removing the upper portion of the yoke, which in this form of machine leaves the table as stiff and in every way as strong and efficient as before.

This machine is of such general dimensions as to nicely adapt it to automobile engine work, and the cross motion of the platen is sufficient so that cylinders and similar work may be bored and faced on the front and back portions of the platen alternately, thus making it possible to set one piece of work in position while the machine is at work on another.

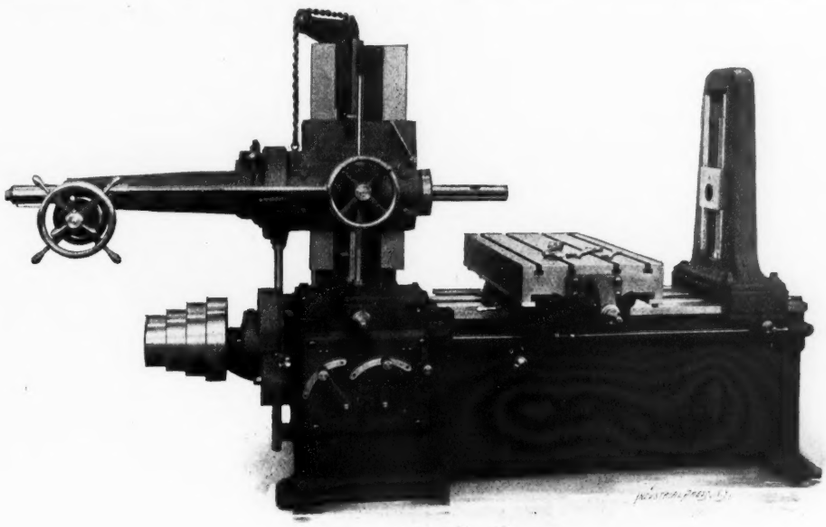
The platen also has a milling feed, and the vertical milling feed to head, which is a regular feature of the larger machine, may be applied to this machine when desired.

The screws are all precision screws, cut in special hard steel, with adjustable dials graduated to thousandths of an inch, so that holes may be bored or surfaces milled an exact distance apart without jigs, and what is of more importance work may be varied when an opportunity for improvement in design comes, without the necessity of throwing away or making over expensive jigs.

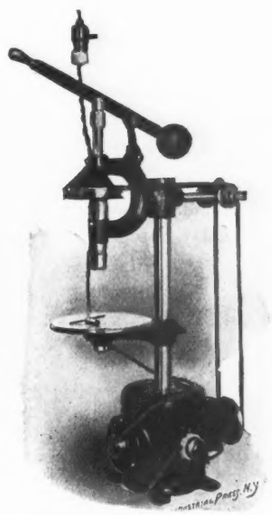
The spindle is crucible steel, and all working parts are ground or scraped. The machine is fitted with all modern improvements in the way of quick power moving devices, geared feeds, friction safety devices, etc., and it is adapted for either belt or motor drive.

BENCH DRILL.

An exceedingly neat electrically-driven bench drill has been brought out by Bartz, Wygant & Brown, Hornellsville, N. Y. The motor which operates the drill forms the base of the machine and is supplied with lugs for attaching the drill to the bench. The drive is by a round belt, as shown, two belt speeds being provided. A sensitive lever feed is supplied. Other speed changes are obtained in the motor itself and current is taken directly from a lighting circuit of 110 or 220-volt current, by attaching to a lamp socket. The capacity of the drill is for holes up to ¼ inch in diameter. Its weight is 100 pounds. The driving pulleys on the spindle are protected by a suitable shield. The table may be adjusted into any position, vertically or horizontally, by sliding on the cylindrical column.



Lucas Horizontal Boring, Drilling and Milling Machine.



Bartz, Wygant & Brown Bench Drill.

AUTOMATIC DIE-HOLDERS.

A new automatic hollow shank die-holder for screw-machines has been brought out by the Garvin Machine Company, New York, and is shown in the cut, Fig. 1. This die-holder is specially designed for high speed, and overcomes many of the defects which develop in these tools, when used under such conditions. It is clutched positively, going forward; but on reverse, when the die is in rapid rotation, and must be stopped,

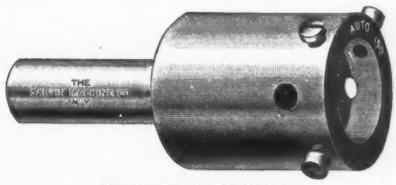


Fig. 1. Garvin Die Holder.

it is held by friction grip, so that it is noiseless in action, and reverses without shock and clatter. The die reverses itself instantly and automatically on throwing the shipper and begins to run back of itself. The hollow shank permits long work to pass clear through, but the working parts are protected from chips and grit.

The construction of the die-holder is readily understood from Fig. 2. The sleeve *A* carries the die in the recess *B* and is mounted on the shank *C*, which goes in the turret. When running the die up on the work the sleeve *A* is clear to the left and is clutched to the shank *C* by the square clutch pins *D*, which lock the sleeve from rotating. When the turret

slide strikes the stop, the die is drawn forward until the pins *D* are out of engagement and stand in the position shown. The ring *E* prevents the sleeve *A* from sliding too far forward.

On reversing to run the die off, the sleeve *A* starts to rotate with the work, but is checked at once without shock by the three friction pawl rollers *L*, shown in the end view. Three grooves are milled in the body of shank *C*, and in each groove is a roller, *L*. A flat spring *M* keeps each roller over toward the

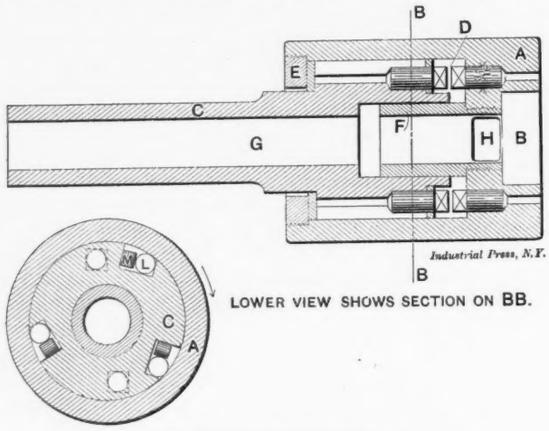


Fig. 2. Details of Die Holder.

side of the groove. When the sleeve *A* starts to rotate in the direction of the arrow, on reverse, the rollers *L* bite at once on the inside of the sleeve *A*, which is hardened, and hold it from rotating while running back. When the sleeve is rotating free with the work in the opposite direction to that of the arrow, just previous to reversing, the rollers *L* oppose no resistance. The shank *C* has a hole *G* clear through to pass long work ,and the tube *F* prevents chips and grit reaching the clutch parts. Egress for chips is provided by openings *H*.

O. K. PLANER TOOL HOLDER.

The O. K. Tool Holder Company, Shelton, Conn., have just brought out the heavy planer tool holder shown in Fig. 1, which is particularly well adapted to the economical use of the costly grades of high-speed steel. The tools, shown in Fig. 2, are drop forgings, made in the characteristic forms adopted by this concern, that is, with a shank fitting into the holder and the body of the cutter resting on a shoulder so that the thrust of the cut is sustained in the most rigid and secure manner without imposing excessive strains on the locking screw. The method of locking the cutters is simple and unique. The locking nut, shown behind the cutter in Fig. 1, fits a short stud which is notched at its lower end, and in this notch is fitted the inner end of the locking wedge. When the nut is tightened with the wrench the stud is lifted and the wedge is forced

Fig. 1. New Planer Tool Holder.

outward against the back of the cutter. Because of the peculiar construction of the tool holder, as just mentioned, the force required to hold the cutters in position is a minimum.

Fig. 2. Set of Tools for Planer Tool Holder.

For this reason the convenient method of locking can be used, and with it there is no trouble from twisted setscrews, etc. The holder is of the offset variety, the working edge of the cutters being located back of the shank. The shank measures 16½ inches in length and 1¼ x 2 inches cross section. Twelve tools made of Novo steel are supplied with the holder; the finishing tool shown in the holder has a 1¼-inch face which gives an idea of the strength and size of the tool. Each tool is positively located by the locking wedge so that when grinding becomes necessary, it may be removed, sharpened and replaced without disturbing the holder or the precise setting of the cutter.

LEATHER BELTING.

The subject of leather for power transmission purposes is one of considerable importance in a power or manufacturing plant. The E. F. Houghton Company, Philadelphia, Pa., have produced a new mechanical leather under the trade mark of "Vim," for which strong claims are made as to durability. This leather is furnished for belting, friction disks and other similar purposes. We are informed by this company that they do not hesitate to fill an order for leather with guarantee that

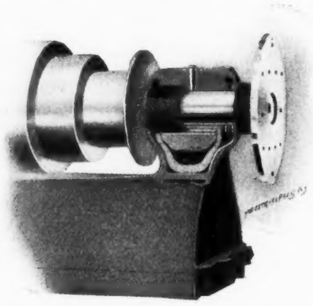
"Vim" Leather. Oak Leather.

it will wear twice as long as oak-tanned leathers, and where the strain is severe, as for instance, in hydraulic packings, they state they will even guarantee more favorable results in wear.

The illustration herewith shows a piece of oak-tanned and a piece of "Vim" leather, which were partially cut and then torn apart. The fibers in the Vim leather appear to have been preserved better than in the case of the oak leather and are less brittle. This presumably is the explanation of the superior results that have been obtained with this leather.

PATTERNMAKERS' LATHE.

A 10-inch patternmakers' lathe, especially designed for manual training schools, has been placed on the market by Fay &



Main Bearing of Fay & Scott Lathe.

Scott, Dexter, Me. This lathe is neat in design, substantially built, and has self-oiling bearings in the headstock. A sectional view of one of these bearings is shown in the accompanying figure. There is an oil chamber beneath the bearing with a wick feed for the oil, and annular grooves at each end of the bearing return the oil to the reservoir.

The lathe spindle is of high-carbon steel and runs in bronze boxes. The rest holder and tailstock are fastened to the bed by a cam lever which operates instantly and positively and serves as a handle for moving these parts on the bed.

COMPOUND VERTICAL SPINDLE MILLING ATTACHMENT.

This attachment is for use on different sizes of plain and universal milling machines of the knee type having overhanging arm. It is applicable to a large variety of drilling, spiral milling, milling angular slots in surfaces of any angle, T slots, keyways and work of a similar character. It is rigidly

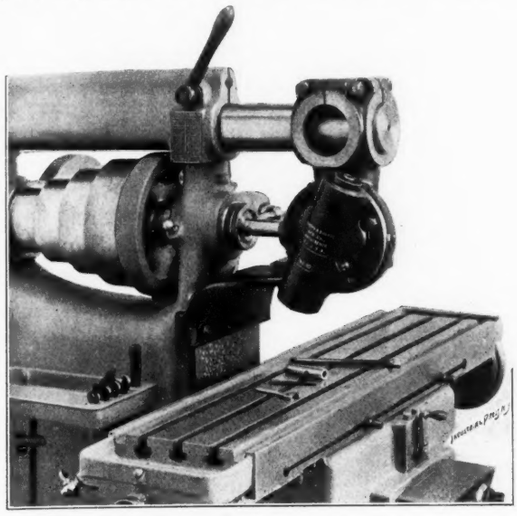


Fig. 1. Compound Milling Attachment; it may also be attached to the Spindle at right angles to position shown.

held in position; the upper part of the frame or head being clamped to the overhanging arm and the lower part to the face of the column by means of a heavy bracket.

The illustration, Fig. 1, shows the attachment in place so as to mill in a plane at right angles to the milling machine spindle. The attachment can, however, be set at right angles

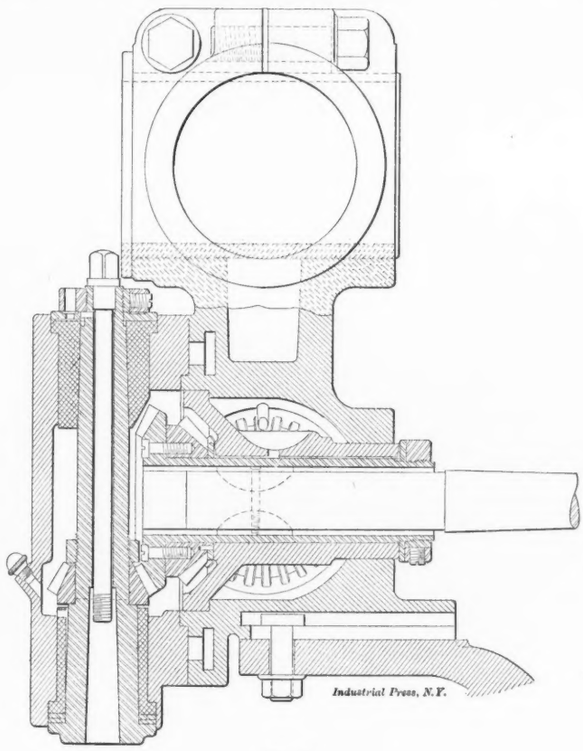


Fig. 2.

to the position shown in Fig. 1, so that its spindle will swing in a plane at right angles with that of the milling machine spindle. It will be noted from the illustration that the attachment is bored out with two holes at right angles with each other, to fit the milling machine bar; and that the attachment has two hollow spindles at right angles with each other, by which it can be driven from the milling machine spindle in either position.

The spindle is driven through bevel gears by a horizontal shaft inserted in the main spindle of the machine, and can be set to any angle from a vertical to a horizontal position. A valuable feature of the device is that when set in a plane at right angles to the table, annular milling can be performed by an ordinary end mill, and the full travel of the table is available for such work. It is therefore well adapted for milling long angular strips, lathe ways, etc., where ordinarily an angular cutter would be required.

The position of the spindle is indicated by graduations on the back of the head, reading to degrees. The spindle has a No. 7 taper hole, and a draw-in bolt is furnished for use in holding collets in the spindle. Details of the device are clearly shown in the sectional view, Fig. 2. This attachment is manufactured by the Brown and Sharpe Mfg. Co., Providence, R. I.

REAMERS WITH HIGH-SPEED STEEL BLADES.

We illustrate below a hand reamer and a shell reamer whose chief feature is that the blades are of high-speed steel. The tools themselves consist of a body of soft steel, to which are brazed blades of high-speed steel, making a solid reamer. The advantage claimed by the manufacturers, the Three Rivers Tool Co., Three Rivers, Mich., is that whereas the use of high-speed steel for reamers has not been practicable owing to the great cost of the stock, reamers like those shown can be had at a slight increase over the cost of the ordinary tool, yet securing the advantages to be derived from the use of high-speed steel.

A large center is provided so as to prevent the reamer from slipping from the tail center and cutting a groove in the end of the shank. This center is casehardened, as is the flat for the point of the dog screw. The square on hand reamers,

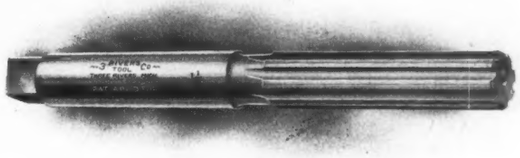


Fig 1. Hand Reamer.

the tangs on drill reamers and the shanks fitting turrets of the chucking reamers are likewise casehardened. These tools are ground all over after all hardening operations are completed. Fig. 1 shows the hand reamer; Fig. 2 the shell reamer.

It is often desired to expand a solid reamer (either hand or machine). Owing to the soft body of the reamers here shown a hole may be drilled in the center of the fluted end, slots

Fig. 2. Shell Reamer.

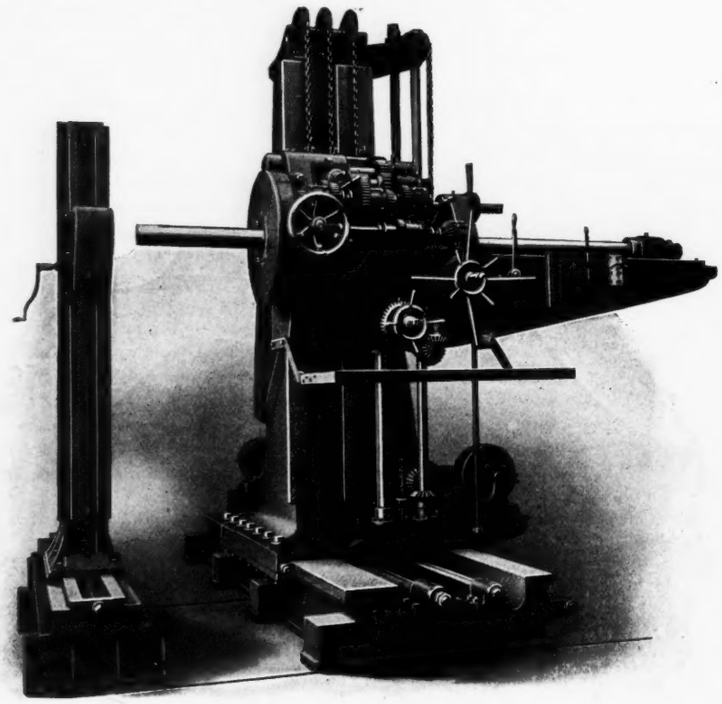
cut in the grooves, and a taper pin or screw used to expand the tool in any of the ways in common use. The Three Rivers Company have sent us some data regarding results obtained with these tools in the shops of the Sheffield Can Co., of their city, which certainly prove the efficiency of their reamers. They are made in any style desired.

The Charter Gas Engine Company, Sterling, Ill., have brought out a small horizontal type of engine to meet the demand in small sizes for a reliable engine that can be purchased at a low price. We are informed that the machine is substantial and the workmanship good, although the cost of production has been reduced to a minimum.

HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

This machine is a new production of the Detrick & Harvey Machine Company, Baltimore, Md. The saddle carrying the spindle has a vertical movement on the face of the column of 72 inches and the column has a movement of 72 inches (or more if desired) on the runway. Fast and slow movements are provided for the saddle and column; and power feeds and quick return for the spindle in either direction. There are also hand feeds for all the different motions.

The runway is a heavy box-shaped casting having a front slideway 14 inches wide and a rear slideway 8½ inches wide.



Seventy-two inch Horizontal Boring and Milling Machine.

The width over all is 56 inches. The driving gearing and motor for operating the spindle and feeding column and saddle are located at the rear of the column.

The spindle is of hammered steel, 5½, 6, or 6½ inches in diameter with a No. 6 Morse taper hole in the end. It is ground to a fit in a sleeve 46 inches long. The sleeve is slightly tapered on its outside and revolves in a bronze bushed bearing 37 inches long in the saddle. Bronze thrust and take-up washers are provided. The work bed is 12 inches deep, tongued and bolted to the runway. The outer support for the bar is fitted with a stationary bushing which has a bearing of 24 inches on the face of the post.

There are eight boring and drilling feeds, which are reversible, and range from .007 to .4 per revolution of spindle. The saddle and column are also provided with eight milling feeds ranging from .01 to .5 per revolution of spindle. The spindle speeds are 20 in number, 10 through the sleeve gear and 10 through the faceplate gear. The speed changes are obtained through the cone and by clutches operated by levers. Four changes are obtained by shifting the levers, and without changing the step of the cone. All the several hand levers for controlling the machine are within reach of the operator when standing on the platform attached to the saddle. The rapid movement of saddle and column is obtained from a separate motor mounted on a supplementary base at the rear of the runway.

MANUFACTURERS' DRILL WITH AUTOMATIC REVOLVING CHUCK.

The B. F. Barnes Company, Rockford, Ill., have brought out a new automatic revolving chuck to be used in connection with their 14-inch and 20-inch manufacturer's drills which have self-operating spindles. Fig. 1 shows a two-spindle 14-inch drill, one spindle of which is equipped with the automatic chuck.

The spindles are independent, being driven from quarter-turn countershafts. A chain running from a sprocket wheel on the lower cone shaft drives a sprocket wheel near the top of the machine, which in turn operates the spindle by means of a friction device. The spindle is provided with adjustable stops for regulating the depth of travel. As soon as the automatic stop has thrown out the feed the spindle is immediately backed out of the work and returned to its first position by means of the friction device mentioned. There is a cam mech-

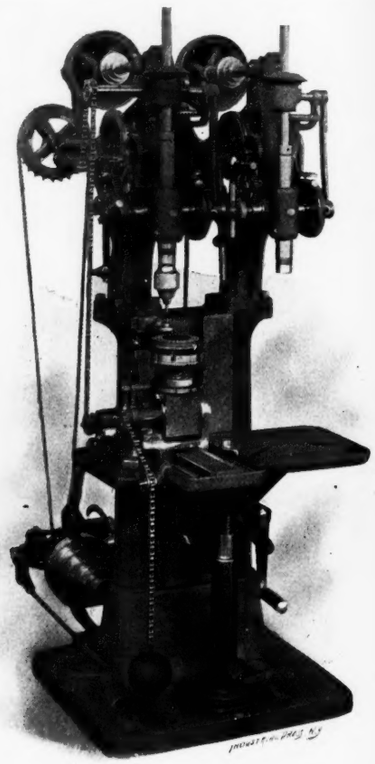


Fig. 1. Manufacturers' Automatic Drill

anism on the other side of the spindle which throws in the feed at the moment the spindle has descended to the work. This cam has two stop pins, one of which causes the spindle, when raised up, to stop until the operator trips same by means

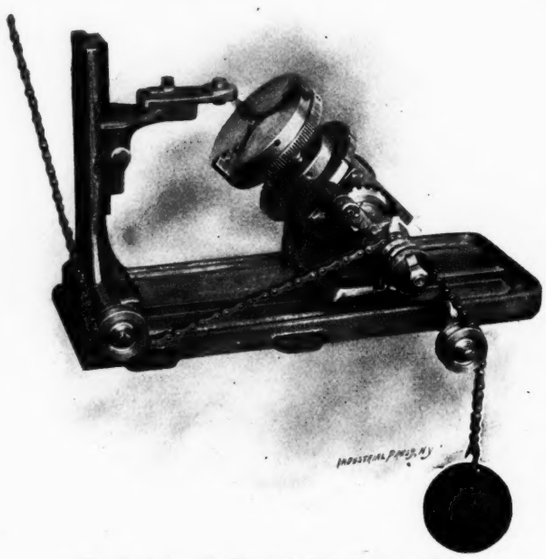


Fig. 2 Automatic Chuck for Manufacturers' Drill.

of a lever in front of the machine. When using this machine with the automatic revolving chuck, however, the stop is removed so that the spindle, instead of stopping upon the return, will immediately drop down to the work again, drill to the

required depth at proper speed, then quickly return, and so on.

The chain operating the automatic chuck, as shown in both Figs. 1 and 2, is attached to a gear under the control of the friction mechanism mentioned above. This chain carries a weight on the end for taking up the slack. The mechanism of the chuck consists of a horizontal shaft on which is a sprocket, over which the chain passes; and a friction clutch connecting the sprocket with a pair of bevel gears for rotating the chuck. The distance the chuck is spaced is determined by a notched plate. A plunger fits in each notch in succession and is disengaged from its notch and allowed to drop into the next one successively by a spring mechanism operated by the sprocket wheel. The spacing of the chuck occurs when the drill spindle is being backed out of the work.

A plate with any desired spacing of notches can be used, either regular or irregular. Any style of chuck may be used, the one shown being an ordinary three-jaw chuck. Above the chuck is a guide for small drills, which is attached to a vertical arm clamped to the base which supports the chuck. The chuck can be inclined to any desired position for angular drilling. For certain classes of work the spindles of this drill may be equipped with an auxiliary double-spindle attachment whereby two drills may be used at the same time, both operated by one spindle.

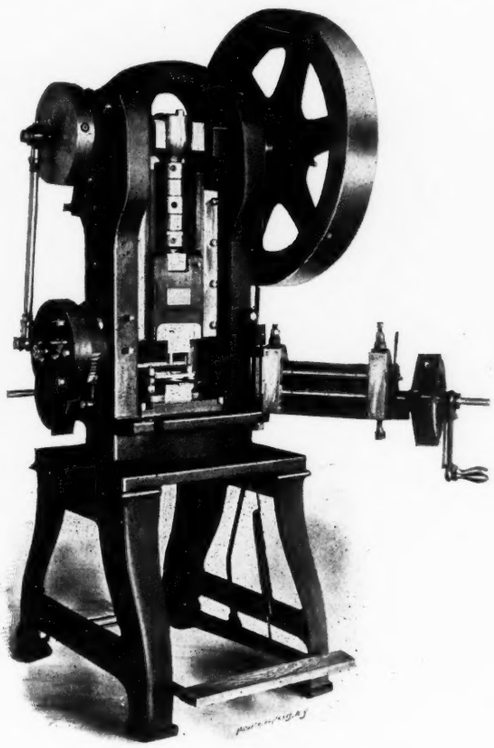


Fig. 1. Coin-cutting Press. Front View.

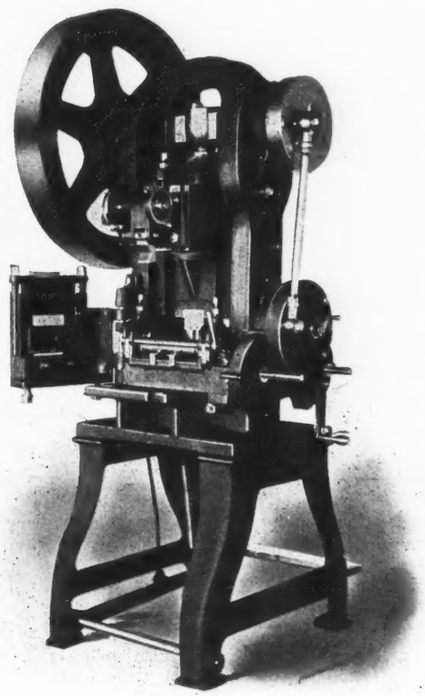


Fig. 2. Rear View.

AUTOMATIC COIN-CUTTING PRESS.

The accompanying cuts illustrate a new planchet or coin blanking press embodying a number of features which we are informed have not been used before on similar presses. A high-speed automatic blanking press was wanted, in which could be had absolute accuracy, easy adjustment of die and punch, ready access to double roll feed and other working parts, and the punched metal taken care of without an extra operator, and the above machine was built to meet these requirements. Fig. 1 shows a front view and Fig. 2 a rear view.

The most important advantage of this machine is the swinging double roll feed with its adjustable feeds and gages. These gages and feeds are not disturbed when rolls are swung out from left to right, leaving a clear die space with no hindrance, either in front or back of die table or press bed. In the older method of lowering the rolls in front or rear of press table, the rolls are not much out of the diesetter's way, as they always project out far enough to be troublesome, and when ready to be placed back into position it usually requires two men to lift them into place and secure them properly, while with the method here illustrated, the diesetter can do all this work alone. The indexing device is not disturbed while the rolls are disengaged.

The feeding mechanism is of a good design, and is fitted up in the best possible manner, both as regards material and workmanship. In view of the fact that these machines are largely used by governments for coin cutting, a superior construction is necessary. The dies and punches in such machines must frequently be changed, often several times a day, which makes time-saving mechanisms an absolute necessity.

Another new feature of this press is the scrap-cutting device. By means of this device the scrap metal may be cut into small pieces after every stroke of the press, or, by adjusting this cutting device, the scrap can be cut into pieces 3 or 6 inches long. The government generally prefers the 6-inch lengths, claiming there is less loss than if cut at every stroke of the press. They also claim that the scrap in 6-inch lengths is much more convenient to handle and more readily handled for remelting.

The cutting capacity of this press, when the automatic roll feed and scrap cutting devices are in use, is two blanks at a stroke of the one-dollar size, three of the half-dollar size, four of the quarter-dollar size, and four of the nickel or penny sizes. Dimes could be cut five at a time. The metal, however, is usually rolled to the width of a single dollar. The dollars and half dollars are at present cut one at a time, quarters two at a time, nickels, dimes and pennies three at each stroke. As the speed of the press is 100 strokes per minute, from 100 to 300 planchets can be cut every minute, which is considered a very good production for one machine. The dies being easily removed, can readily be repaired when worn.

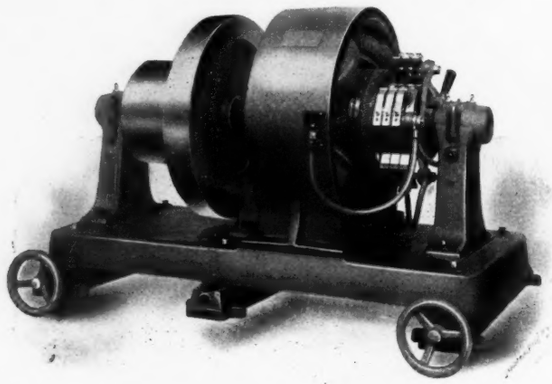
This press with feed will take metal as wide as 5 inches, although the regulation width of metal is only 1¾ inches. At the time this press was designed, rolling the metal into wider strips was considered, so as to increase the output of each machine.

By removing the roll feed and scrap cutting devices, and fitting the press with single dies, it may be used as a coin proving press.

The E. W. Bliss Co., Brooklyn, N. Y., manufacturers of these machines, inform us that governments using them find them very satisfactory.

DIRECT-CURRENT GENERATORS.

The Commercial Electric Company, Indianapolis, Ind., are manufacturing a line of direct-current generators especially designed for use in gas or gasoline engines. For this purpose, on account of the irregular impulse of the engines, it is necessary to provide a flywheel which will overcome the fluctuations of the dynamo speed and produce a steady light, which is impossible where the irregularities of the engine speed are reproduced in the armature of the dynamo. This requirement has sometimes been imperfectly met by manufacturers by placing a heavy wheel upon an extension of the armature shaft, without providing any additional support for this wheel. As standard dynamo bearings are generally not sufficiently heavy to sustain the extra weight of the flywheel, this method has given but slight satisfaction. In order to satisfactorily overcome these speed fluctuations without imposing unusual strains upon the dynamo parts, the company have designed special machines having an extra heavy shaft, which is extended to receive a heavy flywheel and which is supported by three bearings, two of which are placed close upon either side of the flywheel, where they will support its weight and receive the extra strain caused by the jerking of the dynamo belt without injurious effect upon the dynamo. These three pedestals, with the machine frame, are mounted upon a heavy iron base, which is carried upon sliding rails with handwheels and thrust screws, by means of which the belt tension can be adjusted. By this construction the overloading of the dynamo bearings or the expense of an extra countershaft for carrying the flywheel is avoided, and a substantial mechanical machine, capable of producing a steady light, is secured.



Generator and Fly-wheel for Gas Engine Connection.

MOTOR-DRIVEN BOLT CUTTER.

The accompanying cut illustrates the general design of a new motor-driven double bolt cutter recently brought out by the National Machinery Co., Tiffin, O.

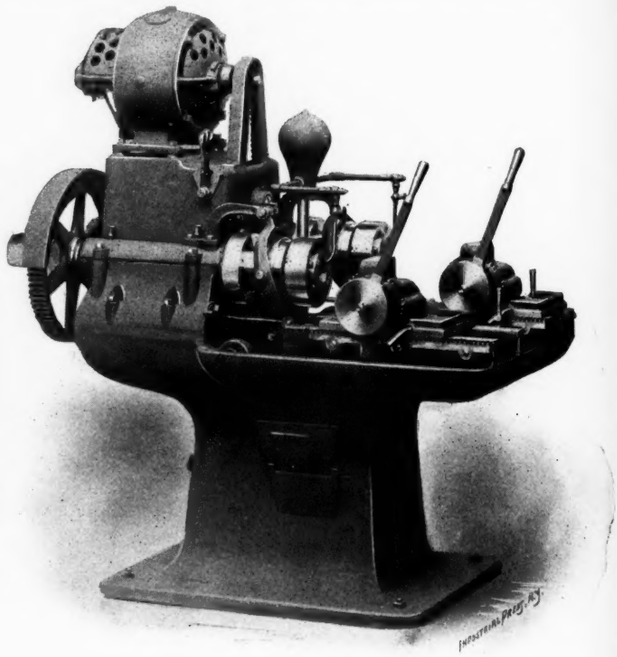
In the construction of this machine the aim was to so build it that any standard motor could be used. With this idea in view the gearing has been so designed that a great range in speed is secured in the gearing, although the gearing is neither intricate nor bulky. Any constant potential as well as multi-voltage motor can be used, as a speed variation of 40 per cent. is all that is required in the motor.

The motor is placed on top of the housing which carries the change gears, and drives the gears through a silent-running chain. All parts are protected from dirt and chips and special care has been given to the oiling system to insure perfect lubrication.

Three changes of speed are secured in the gears, and the design is such that when the machine is running on the high-speed the change gears are out of mesh. The various changes are secured by means of a latch pin and a shifting lever, shown at the side of the housing. A controller having any number of steps can be used, but with a controller having three steps, nine speeds are secured having regular even gradations. This provides proper cutting speeds for all sizes of bolts from $\frac{3}{8}$ to $1\frac{1}{2}$ inches varying by one eighth of an inch.

This machine is said to be peculiarly well adapted for motor drive, owing to the ease of operation of the cutting heads and the simplicity of the single lever vise and carriage movement, which enable the machine to be run at a high rate of speed. The machine is provided with force feed lubricating pump, and chip and oil pans, and there is an air chamber so that a constant stream of oil of considerable force is secured, insuring long life to the dies even when running at high speeds. All gears and racks are cut from solid stock. The carriages are provided with removable gibs to take up wear, and the vise jaws have removable grips made from hardened steel. There are centering devices on the vise jaws to enable the bolts to be cut to be properly centered with the dies. The die heads are of the "National" open-die type, which are automatically opened and closed by the movement of the carriages. The positive lock on these heads holds the dies rigidly in position when cutting threads, insures uniformity of production, prevents the cutting of tapering threads, and removes wear and friction from the sliding surfaces.

This machine can be furnished with power feed; and lead-screw attachments for special thread cutting. It is also furnished in sizes from $\frac{3}{4}$ inch to $2\frac{1}{2}$ inches capacity.



Bolt Cutter Adapted for Motor Drive.

A NEW STEEL PULLEY.

Phillips, Townsend & Co., Philadelphia, Pa., pioneers in the wire nail industry, are putting on the market a new pressed steel pulley, the invention of Mr. Ferdinand Phillips, proprietor of the firm, and also of the Phillips Pressed Steel Pulley Works, under which title the new departure will be conducted. The pulley is characterized by an extreme originality in design and is the result of long study and experiment on the part of its inventor. We believe that a close examination of the details of the pulley will not only show the details of construction to be fundamentally new but also that the design is unusually well adapted for sustaining stresses incident to power transmission.

The hub of the pulley is made of cast iron, approaching in design the conventional hub of a split cast-iron pulley. The hub is made in halves and may be secured to the shaft by compression only, if desired; or a setscrew or keyseat may be provided. Bushings are also supplied to suit shafts of different dimensions. In these several respects, therefore, the pulley is as well adapted to the varied requirements of power transmission as is the hub of the ordinary type of cast-iron pulley.

The arms of the pulley are of triangular truss pattern. It is contended by Mr. Phillips, and we believe correctly, that

pulleys with radial arms are essentially wrong. They are imitations of a cartwheel, which requires a radial post under the burdened axle as the most direct means of supporting the load; but this is different in pulleys where the strain is applied tangentially to the rim. The arms are corrugated to provide strength for transverse strains. They form a central spider which is so strongly braced as to be self-sustaining, and power

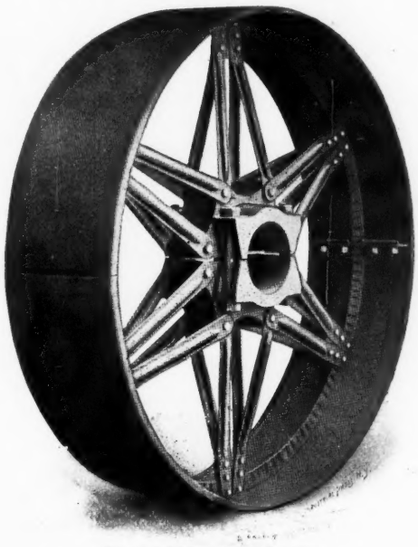


Fig. 1. Phillips Steel Pulley.

is transmitted from the spider to the rim, or vice versa, in a tangential direction. The rim and the spider are each stiff enough to withstand the strains that come upon them without in any way depending upon the other member for support. A feature not appearing even upon close inspection, because of its being covered in the construction of the wheel, is a means for relieving the rivets holding the members together from the strain of power transmission. This is accomplished at the hub by countersinking the metal of the arms into the cast iron of the hub, and at the rim by means of gusset plates, designated in this case as "dowel plates." These dowel plates interlock with recesses in the central rib of the rim and the strain comes upon these plates instead of upon the rivets attaching the arms to this rib. These details are shown in Figs. 2 and 3.

The most novel part of the pulley is the rim, which is formed of sheet metal in the shape of a T. The head of the T represents the face of the pulley. On the edge the metal is doubled over itself and finally bent in a vertical direction to the face,

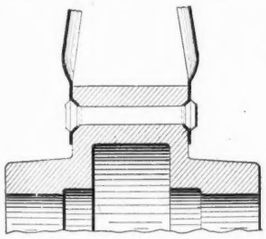
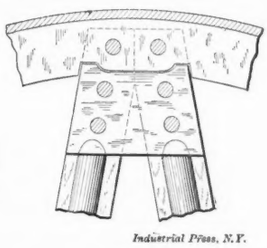


Fig. 2.



Industrial Press, N.Y.

Fig. 3.

thereby forming the central rib. As the writer can testify, this peculiar construction, presenting a smooth, unbroken face with one central rib, has puzzled many casual observers. It is best understood by reference to Fig. 5.

All parting pulleys are weakest at that part of the rim where the two halves are brought together, and unless the best precaution is taken to keep the two abutting halves in perfect relation to each other, there is imminent danger to the life of belts from chafing owing to the sharp edges of the metal of the two abutting halves not meeting correctly. In the Phillips pulley the rim lugs are an integral part of the rim and extend over the whole width of the pulley, imparting to the pulley unusual strength at the joint.

Small details have likewise received proper attention. Every practical mechanic abhors the vexatious use of two wrenches in putting split pulleys together. This has been rendered unnecessary by the use of channel bars, extending over the whole row of bolts. The heads of the rim-lug bolts are bedded in these channel bars preventing them from turning when the opposite nut is screwed up.

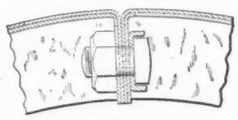
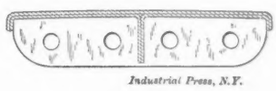


Fig. 4.



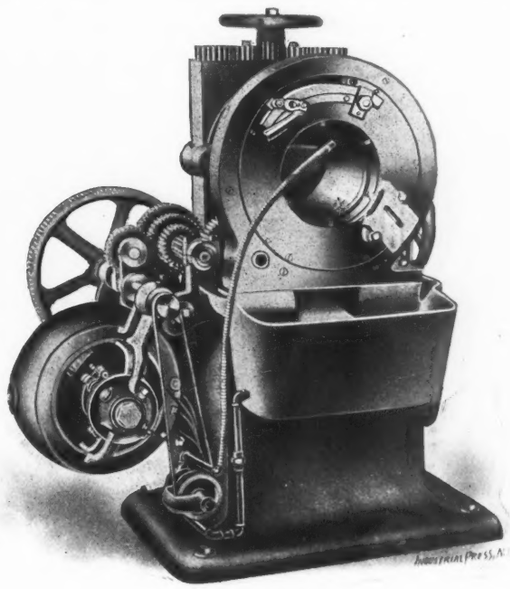
Industrial Press, N.Y.

Fig. 5.

The several parts of this pulley are manufactured separately and of various gages, suitable for all exigencies and conditions and finally assembled into the finished pulley.

MERRELL PIPE-CUTTING MACHINE.

The motor-driven pipe-cutting, threading and cutting-off machine shown herewith is a combination hand and power machine mounted on a suitable base and equipped with a motor which drives through a variable speed gear mechanism, consisting of an idler pinion and a nest of gears. The illustration shows the machine without a protecting hood over the gears, but as regularly equipped a hood is provided. The rheostat is inside the base and the starting lever in a convenient location at the side of the machine. The motor is connected with a double spindle so the machine can be run either right or left. In addition to the motor drive, power may be applied either by crank or ratchet. The machines have an adjust-



Motor-driven Pipe Cutter.

able quick opening and closing diehead, and an improved cutting-off knife. The chasers are five in number. They can be sharpened by grinding and are readily replaced by chasers of any style or pitch of thread. The vise is self-centering and is actuated by a rack and pinion to feed the pipe into the chasers. The machine is built by the Merrell Mfg. Co., Toledo, O.

EMERY WHEEL DRESSERS.

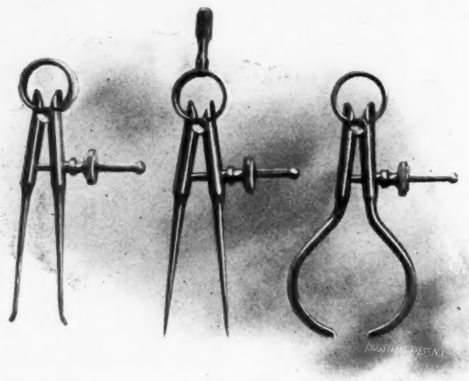
The Diamond Saw & Stamping Works, Buffalo, N. Y., are now marketing an emery wheel dresser handle which is designed to be of great usefulness to the workman. The dresser cutters are of high-carbon steel and so tempered as to be very durable. The handle itself is made of stamped steel, is strong and light. The cutters revolve on an axle pin of hardened tool steel. These cutters are put up in sets of four with two washers, each set being neatly boxed in a small carton. The manufacturers claim for these dressers, known as the "Sterling," superior quality, economy of price and durability.

CALIPERS AND DIVIDERS.

The half-tone herewith illustrates the new line of inside and outside spring calipers and spring dividers recently placed on

the market by the Brown & Sharpe Mfg. Co., Providence, R. I. The main feature of these new tools is that they have round legs instead of the flat form usually seen, and this radical departure from the well-known lines gives to the tools a great rigidity. They are especially designed to meet the demand of toolmakers and others engaged in fine work for a tool that will be rigid, light and durable.

The fulcrum stud is hardened to reduce wear and prevent roughing up of the bearings. The spring is very stiff and



Brown & Sharpe Tool-makers' Calipers and Dividers.

has concave ends that fit into grooves milled in the ends of the legs. This is to insure rigidity and prevent side deflection of the legs. The legs are of steel, highly polished; the measuring points come together evenly and the screw is of fine pitch and provided with a solid nut and hardened thrust washer. These tools are manufactured in 2, 3 and 4-inch sizes.

MACHINISTS' RULES.

The accompanying cut illustrates a most convenient little rule for machinists' use. It has a knurled handle which enables the user to hold it steadily in the hand, and by placing the rule at an angle it may be used in many places where it is impossible to get with the end graduation of an ordinary rule. The back corners of the scale blade are rounded, which makes it very convenient to move with the thumb while holding in the hand.

Rules with Handle Attachment.

This rule is particularly handy in setting up screw machines, in milling machines, in lathe work where there are grooves and short shoulders to be turned and where oftentimes the tailstock center is in the way when measuring small work. It is especially useful in tool and die making, and in fact, for all kinds of machine, large and small work, there are many places where these rules may be used to advantage

The rule is the product of W. E. Severance, Revere, Mass.

FLOAT BALLS.

The Toledo Machine & Tool Company, Toledo, O., have recently devised a new method of forming float balls for water tanks. The balls instead of being spun into shape are made complete with dies on a Toledo open-back inclined press.

Each half of the ball is drawn in two operations and the outside edges are afterward trimmed and folded. The two halves are then clamped together by means of a closing die. In this closing die a very ingenious device is used which closes the halves of the ball so tightly together that very little solder is necessary to make the ball air tight.

The floats are produced in a much neater and smoother manner by this method than by spinning them into shape and are produced at from 50 to 60 per cent. less labor cost with the dies than is possible with the old method. Another great advantage is that no great expense or outlay is necessary to put in an equipment for doing this class of work.

PIPE CUTTER.

The Wilson pipe cutter, made by the Curtis & Wilson Machine Company (Goldsborough & Smith, 72-76 Trinity Place, New York, sole agents), is designed for cutting cast-iron pipe, and the tool is held in such a manner as to provide suitable rake and clearance so that a clean cut is made, leaving the pipe without a burr. There is no tendency of the machine to

Improved Cutter for Cast Iron Pipe.

Pipe Cut with Ordinary and with Improved Cutter.

crush the pipe, the tool acting like a lathe tool. The pipe can be threaded immediately after being cut, without being removed from the machine, inasmuch as the vise can be employed like an ordinary pipe vise. The operation of the cutter will be clear from the illustration.

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NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes.

THE SPRAGUE ELECTRIC CO., New York. Bulletin No. 219 of round type motors, direct-current. This pamphlet is profusely illustrated.

THE DIAMOND SAW & STAMPING WORKS, Buffalo, N. Y. Booklet illustrating the hacksaw blades and frames made by this company. Sizes and prices are given.

THE LEWIS FOUNDRY & MACHINE CO., Pittsburg, Pa. Catalogue No. 14 of shears, roll lathes, engines, hydraulic machinery and miscellaneous machinery. Handsome cuts illustrate the various machines.

THE SHELBY STEEL TUBE CO., Pittsburg, Pa. Advertising card illustrating this company's exhibit at St. Louis. This is a sort of booth built, we judge, entirely of Shelby steel tubing.

THE MAGNOLIA METAL CO., New York. Illustrated booklet of the "Magnolia" metal manufactured. It contains testimonials regarding this product, a price list, some useful tables, etc.

THE CURTIS & WILSON MACHINE CO. Leaflet pertaining to the Wilson pipe cutter for the cutting of castiron pipe. Messrs. Goldsborough & Smith, 72-76 Trinity Place, New York, are sole agents.

F. W. BRAUN & CO., Los Angeles, Cal. Pamphlet entitled "Annealing Hardening, Tempering and Casehardening," with information concerning the company's portable forge and tempering furnace, and some useful hints regarding the operations of annealing, hardening, etc.

THE CHARLES G. SMITH CO., Pittsburg, Pa. "Album of Machine Tool Illustrations," being a collection of illustrations of the products of prominent manufacturers in the machine tool field whom this company represent.

THE NORTHERN ELECTRICAL MFG. CO., Madison, Wis. Leaflet No. 130 calling attention to the advantages of the "Northern" spherical motors for driving purposes. Illustrations are given of these motors driving a buzz saw, a swing cut-off saw, a woodworking lathe, etc.

THE RAND DRILL CO., 128 Broadway, New York. Pamphlet illustrating and describing some of the company's standard types of air and gas compressors. Complete information may be had by writing for their catalogues.

THE COBURN TROLLEY TRACK MFG. CO., Holyoke, Mass. Catalogue of the Coburn trolley track, showing them in operation in various places. These are equipped some with self-locking block, others with electric hoist, etc.

THE HEALD MACHINE CO., Worcester, Mass. Illustrated catalogue of the "American" drill grinders, belt and motor driven. This company also manufacture the "Heald" wet cutter and grinder, the "American" center grinder, and the "Heald" piston ring grinder.

THE GRANT GEAR WORKS, Boston, Mass. 1904 catalogue and price list of gears. Herein are listed brass gears, brass racks and ratchets, internal gears, worms and worm gears, sprockets and chains, iron gears, etc., etc. Valuable tables and charts, relative to gearing also appear.

THE CHESTER B. ALBREE IRON WORKS, Allegheny, Pa. New riveter catalogue No. 6, presenting the latest forms of the Pittsburg riveting machines, with descriptive matter relative to same. A large number of useful tables concerning rivets and riveting are also to be found in this catalogue.

THE RAND DRILL CO., 128 Broadway, New York. Novel mailing card in the form of the new "Imperial" hammer. The address is